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IMPACT of science on society

VOL. I. No. 3-4 OCTOBER-DECEMBER 1950

ERSITY OF MICHIGAN
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PERIODICAL READING ROOM

IN THIS ISSUE ARTICLES BY

J. Perrin
A. Einstein
L. de Broglie
P. Auger
M. Sorre
E. Roux

AND

Energy in the service of man

ABSTRACTS

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FOREWORD

EVERY aspect of modern life is affected by the use of natural energy, the development of which has direct repercussions on economic life (machinery, industry, agriculture, transport, etc.), political life (plans for equipment, rivalry for the ownership of sources of energy, particularly oil and uranium), military and strategic planning (motorized armies, atomic weapons, etc.), professionat life (status of miners, training of an ever-larger number of research workers, engineers, technicians, skilled workers, etc.), population changes in certain areas (transfers of workers, drift from the country to mining and industrial centres, etc.), city life (bus and underground transport, heating, lighting and so on), social life for families and individuals (raising of the standard of living, motor-cars, domestic use of gas and electricity, changed style and tempo of daily life, etc.). Scarcely any human activity has been left untouched. Nor must we overlook the indirect results of these changes. A revolution has been brought about, not only in our material way of life, but in our thinking habits and even in our attitude to art.

A full and unrestricted analysis of "Energy in the Service of Man"—the aim of this bibliographical survey—would give us insight into most of the problems of today. In this issue we have concentrated mainly on French books and articles dealing with the direct repercussions on society of the development of energy;[1] the great bulk of them were published in the last 25 years. We have also added a few reports of English publications so as to complete the bibliography given in the previous issue.

Many excellent works have appeared in several others besides the English and French-speaking countries, which obviously do not cover the whole field. As soon as we have assembled the necessary material, we hope to devote space in Impact to these other works.

According to the policy adopted for our journal, the abstracts are preceded by a few particularly significant articles on general problems relevant to the objectives of Impact.

It may not be too soon to draw some conclusions from the survey conducted in this and the preceding issue. One, at least must strike the observer.

Although a very full bibliography is available on the various sources of energy and their different uses, most of the studies are concerned primarily with its production (technical problems output, world reserves, production figures, man-power problems, etc.); a smaller number dwell on the question of consumption (marketing capacity, distribution). But very few consider the consumer himself, who paradoxically appears to be held of little account beside the tremendous effort of production. We seldom find an author discussing the purely human side of the question, the influence of a higher output of energy on the development of the individual or of society. Surely this is a symptom deserving closer attention. Should it not be one of the first duties of civilized man to react against this unnatural tendency and to humanize technology?

The Editor of Impact.

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[1] However, apart from the works wich naturally qualified for inclusion in the survey, we have thought worth mentioning in these bibliographical notes a series of documents treating the questions from a purely technical or economic standpoint, but quoting figures and facts that often tell more than the longest commentary.

PART ONE

Articles

The progress of science

by

J. PERRIN

If the splendid adventure in which humanity has been engaged for almost a generation, and which surely marks the dawn of a new civilization, has been able to proceed at an ever increasing rhythm, it is due solely to the more and more rapid progress of science.

But the human brain has not changed since the times of Archimedes and Pythagoras, and this progress might very well slow down and then cease entirely, from an excess of knowledge which it would be impossible for one mind to assimilate. Fortunately despite the immense fund of knowledge already acquired, and although a statement of the facts and techniques requires, for each partial science, well-stocked libraries, the very sight of which may easily discourage research workers, there has been a simplification of doctrines; and, if the edifice of our knowledge has become much vaster, it has also become more harmonious. Therefore, contrary to what has often been said, far from everyone being obliged to specialize in a limited field of research and activity, it is becoming easier to obtain general views covering wider and wider horizons.

Our knowledge of the Universe is really contained within two perfectly distinct sciences, that of the Inorganic World in which Physics and Chemistry have no real dividing line between them, and that of Life, which is a degree more complex and takes as its primary basis (for the time being, not reduced to simpler elements) all of the properties of the Protoplasm—of that infinitely variable Protoplasm which, during thousands of millions of years and owing to extremely rare accidents, has assumed such different forms as those of the Insect and of Man. It is to be hoped that it will offer tremendous possibilities to those who can recognize and overcome one or other of the obstacles in the path of Evolution.

We should like here, to give a very simple outline of Physics. With regard to observable phenomena, we shall leave aside whatever has in fact been anticipated or co-ordinated simply because it has been possible to imagine certain structures or certain properties not perceived by our senses. In this first volume, therefore, we shall employ almost exclusively the methods by which Thermodynamics were established, and proceed by way of analogy and generalization. We shall then endeavour, as atomists, to divine and utilize, for the anticipation or apprehension of observable phenomena, the secret composition of Matter, Light, or any other constituent of the Universe.

We shall endeavour to omit merely technical details, but to set forth fully all arguments pertaining to Physics proper, considering that our aim, as indicated by the general title under which this volume is published, is to use Science as a means to education, and to make the mind more fitted for Discovery or at least more interested in general ideas. We shall emphasize the importance and content of those undemonstrable principles which are the fruit of centuries of experimentation and in which physicists have reduced to rules setting certain limits to possible experience, a vast amount of miscellaneous observation. With the same end in view, and fully conscious of the difficulty of our task, we shall try to distinguish between merely intellectual habit and logical necessity, and we hope that any youthful reader who may be destined to advance further along this road will fully realize that there is no idea which remains true indefinitely, as we depart further and further from the experimental conditions in which it was formed. In particular, we shall see how the genius of Einstein has revised and extended the concepts of Space and Time which had not changed since early ages.

We would also like to make a few remarks concerning a problem created by the inevitable imperfection of our senses, even in the field in which ordinary notions of space and time can be used without difficulty.

What we call knowledge of an object, or a series of events (the fall of a body, for instance), has so far always implied the forming of a mental image or series of images, real "cinematography of the brain", which can be achieved thanks to the retina and the tactile organs, and which in most cases is at least partially constructed "after the event" and in such a way as to form a whole that is perceived as such, thanks to our memory.

But each of these images is never completely distinct, owing to the fact that the "separative power" of our perceptions is and always will be limited. We can compare ourselves to an artist who wishes to portray objects on a tapestry. He cannot delineate any detail which is smaller than one of the meshes of his canvas, nor can he go beyond the framework which he has chosen for his picture. He can choose to portray a fly or a house, but he cannot portray in the same picture, and in their exact proportions, the house and the fly on the house.

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Is it, indeed, a question of comparison? Is not each of us in the same position as this artist who, in order to reproduce nature, has only a limited space and a canvas with uniform meshes? The space which we construct, thanks to our visual and tactile impressions, cannot have a finer grain than those impressions; and the most delicate of them—the visual impressions—correspond to a retinal tapestry, as it were, whose separative power does not reach the sixtieth part of a degree. Thus it is impossible for us, for instance, when we see the Palais du Louvre as a whole, to perceive, at the same time, the flies on its walls.

Moreover, these are direct sensations. Memories or mental images which are usually the basis of our reasoning are certainly not so fine, nor is their separative power so strong. When, with closed eyes, we form a mental image, we are far from providing it with as many details as a direct perception of it would give us. We can imagine separately either Brittany as a whole or a man walking along a road in Brittany, but we cannot simultaneously form an image of both of them in their true proportions.

Similar remarks apply to the sensations or images produced by length of time or movement, so that our perceptions of Space and Time are subject to the same limitations. Movements, if too slow or too fast, escape our perception. We cannot grasp, as movement, the slow growth of a tree, nor can we grasp the details of a process of combustion whose successive phases appear to us to be simultaneous, if they last less than the twentieth of a second. Here, again, our imagination cannot serve us better than our senses, which provide it with the elements that it combines, and we cannot really follow, in thought, movements whose rapidity exceeds the limits of our direct perception.

While we cannot transcend the limits which our senses impose on our imagination and perception, as regards both synthesis and analysis, we can choose the object to be perceived within these limits, just as freely as an artist chooses the subject he portrays. Moreover, like the artist, we can, through an alteration in the "scale" chosen for observation or reproduction, perceive such and such a phenomenon which at first eluded our notice. We can, for instance, come close enough to the Louvre to see the grain of such and such a stone, as well as a fly crawling over it; but if we do so, we shall no longer be able to see the Louvre as a whole. As we approach a forest, we can distinguish some of the trees in it; but, as the proverb says, these will prevent us from seeing the forest itself. Approaching the foot of such and such a tree, we shall be able to see, in detail, a tuft of moss on it. By completing, with the aid of a magnifying-glass or a microscope, the lens which forms on our retina the image that is then transmitted to the brain, we can observe in a bit of this moss a fragment of follicle, whose image will fill our whole field of vision. In it, we shall discover cells with their nuclei, vacuoles and leucites; and when we have reached the technical limit of magnification, we shall nevertheless know that greater magnification is in fact possible and would reveal to us an even finer structure.

But it must not be forgotten that in all these cases our visual power remains unchanged. We can use it in order to see either the whole forest or merely some of its plant-cells, but in each case we can apprehend just so many distinct details, and no more. A true increase in our visual power could occur only if we changed our retina and our brain in such a way as to increase the "resolving power" tenfold, say, while maintaining unimpaired the faculty of perceiving the images as a whole. But until that is possible, all we can do to understand any given phenomenon is to form, on every possible scale, cinematographic images of it in such a way that each of them fills our vista of space and time, and to use these images like the pages of a book, our attention passing easily from one to the other in, as it were, a fifth dimension.

These variations in scale have been of great service, particularly in that a given fact, or a certain valuable instrument, which might remain unperceived on a certain scale is immediately apprehended on another. Thus the microscopic study of living matter has revealed the nature of contagious diseases—due to visible microbes—and so helps us to cure them. Each scale of observation has its own advantages, and it would be a grave mistake to imagine that the greatest degree of magnification is always the most profitable. We cannot grasp the expression or beauty of a human face by looking at it through a microscope. Nor would Carnot's principle have been easily discovered on the scale of the Brownian movement.

Naturally we shall have to vary the scale of observation in time as well as in space. Here the cinematograph will play the part of a telescope which we can look through at either end according as we wish to make objects appear "nearer" or "more remote". By accelerating or slowing down the motion of a film, we shall see, within the limited range of speed imposed by our sense of movement, the evolution of phenomena which, when directly perceived, seem motionless or undergoing instantaneous change. We shall see, for instance, a flower grow and bloom within a few seconds, or we shall see, within the same short space of time, the successive phases of an explosion. But the simultaneous perception of these two forms of evolution will naturally be impossible. We shall not be able to apprehend, in the same sequence of impressions, the flight of a butterfly and the blossoming of a flower, as the duration of each of these events is out of all proportion to the other.

It is hardly necessary to add that no given "representation" in space and time is truer than any other: a blade of grass is no "truer" under

the microscope than when seen by the naked eye. But both of these aspects and generally speaking all observable aspects of phenomena, contain their respective grains of truth.

In short, our concrete knowledge of things requires the storing and classification in our brain of a "library of films" taken on different scales. There is a two-fold limitation to this: neither the magnification nor the diminution of real objects can be pursued indefinitely.

Certain of the following pages will make it clear that a humanly contructed image is the less faithful, the greater the portion of the Universe it claims to represent. We cannot, for instance, construct in its true proportions a space-and-time model of the Galactic Universe, reduced, say, to terms of metres and hours—firstly, because what would appear simultaneous in our model is not simultaneous in the Universe, and secondly because that Universe, taken as a whole, does not seem to be Euclidean.

But this alone does not represent any serious difficulty. In the absence of a single model, a series of models would be possible, depicting the Universe just as a series of tangent plane charts can depict the spherical Earth, although their combination in a single plane chart cannot reproduce the Earth as a whole.

Greater difficulties arise however when we try to depict, on a space-and-time basis, objects which are increasingly remote from our direct perception, such as molecules, atoms and their components, electrons, nuclei and protons. Here, all the drawings attempted, including even Bohr's famous model, seem to give rise to contradictions. All the ideas formed within the field of our ordinary experience will probably have to be radically altered in order to become applicable to these elements of matter—or perhaps, even, discarded altogether. This may be particularly true of the idea of Space, which was extended far beyond the field of our direct observation—permitting us to define usefully the millionth of a millionth of a centimetre for instance—but which might finally cease to be utilizable for the purpose of describing the inner structure of things, of which it may still be reasonable to say that they are less and less complex, less and less rich in possibilities, but not to say that they are smaller and smaller.

It is a rude jolt for our minds, which were only able to apprehend in Space and Time. What seemed to us logically necessary is no more than childish anthropomorphism and, strangely enough, we are led back to the old Biblical commandment which bears witness to similar reflexions in the past: "Thou shalt not make unto thee any graven image."

We shall not make any graven image; but shall we give up our quest for knowledge? Shall we be of those who regard it as a virtue to resign themselves, in the presence of evils that are said to be natural? Shall we abandon all efforts to discover that strange Order which we believe to exist in the elementary substratum of Things? In addition to many other sacrifices, that would mean abandoning research into atomic evolution; and we might thereby lose all hope of controlling the course of that evolution and of drawing from it the torrents of energy which could be transformed into prodigious wealth, permitting us, if we so desired, to leave the Planet to which we are bound by the forces of Gravitation.

But we belong to a race that is clear of mind and stout of heart, and whose eternal glory it will be that it ventured to confront what appeared to be Destiny. A host of young people is already continuing the age-old efforts to which we owe so many victories, and is succeeding in creating, with a view to describing and anticipating the hidden elements of phenomena, new modes of thought that are developing daily. We shall not, then, lose courage; but, without vainly raising imploring hands towards an empty Heaven, and despite indifferent Forces, we shall continue our march towards a Future that will possibly equal our greatest expectations—a march which nothing yet seems likely to stop.

Préface to Les Eléments de la Physique (*Albin Michel, Paris,* 1929), *reproduced in* La Science et l'Espérance *by Jean Perrin* (*Presses universitaires de France, Paris,* 1948).

On the moral obligation of the scientist

A Message from

ALBERT EINSTEIN

to the "Societa Italiana per il Progresso delle Scienze" on the occasion of its Forty-third Meeting in Lucca, 1-4 October 1950.

Let me first thank you most sincerely for your kindness in inviting me to attend the meeting of the "Society for the Advancement of Science". I should gladly have accepted the invitation if my health had permitted me to do so. All I can do under the circumstances is to address you briefly from my home across the ocean. In doing so I am under no illusion that I have something to say which would actually enlarge your insight and understanding. However, we are living in a period of such great external and internal insecurity and with such a lack of firm objectives that the mere confession of our convictions may be of significance even if these convictions, as all value judgments, cannot be proven through logical deductions.

There arises at once the question: should we consider the search for truth—or, more modestly expressed, our efforts to understand the knowable universe through constructive logical thought—as an autonomous objective of our work? Or should our search for truth be subordinated to some other objective, for example to a "practical" one? This question cannot be decided on a logical basis. The decision, however, will ave considerable influence upon our thinking and our moral judgment, provided that it is born out of deep and unshakeable conviction. Let me then make a confession: for myself, the struggle to gain more insight and understanding is one of those independent objectives without which a thinking individual would find it impossible to have a conscious, positive attitude toward life.

It is the very essence of our striving for understanding that on the one hand, it attempts to encompass the great and complex variety of man's experience, and that on the other, it looks for simplicity and economy in the basic assumptions. The belief that these two objectives can exist side by side is, in view of the primitive state of our scientific knowledge, a matter of faith. Without such faith I could not have a strong and unshakable conviction about the independent value knowledge.

This, in a sense, religious attitude of a man engaged in scientific work has some influence upon his whole personality. For apart from the knowledge which is offered by accumulated experience and from the rules of logical thinking, there exists in principle for the man in science no authority whose decisions and statements could have in themselves a claim to "Truth". This leads to the paradoxical situation that a person who devotes all his strength to objective matters will develop, from a social point of view, into an extreme individualist who at least in principle, has faith in nothing but his own judgment. It is quite possible to assert that intellectual individualism and the thirst for scientific knowledge emerged simultaneously in history and remained inseparable ever since.

Someone may suggest that the man of science as sketched in these sentences is no more than an abstraction which actually does not exist in this world, not unlike the *homo oeconomicus* of classical economics. However, it seems to me that science as we know it today could not have emerged and could not have remained alive if many individuals, during many centuries, had not come very close to the ideal.

Of course, not everybody who has learned to use tools and methods which, directly or indirectly, appear to be "scientific" is to me a man of science. I refer only to those individuals in whom the scientific mentality is truly alive.

What then, is the position of today's man of science as a member of society? He obviously is rather proud of the fact that the work of scientists has helped to change radically the economic life of men by almost completely eliminating muscular work. He is distressed by the fact that the results of his scientific work have created a threat to mankind since they have fallen into the hands of morally blind exponents of political power. He is conscious of the fact that technological methods, made possible by his work, have led to a concentration of economic and also of political power in the hands of small minorities which have come to dominate completely the lives of the masses of people, who appear more and more amorphous. But even worse: the concentration of economic and political power in the hands of a few has not only made the man of science dependent economically, it also threatens his independence from within; the shrewd methods of intellectual and psychic influences which it brings to bear will prevent the development of independent personalities.

Thus the man of science, as we can observe with our own eyes, suffers a truly tragic fate

Striving in great sincerity for clarity and inner independence, he himself, through his sheer superhuman efforts, has fashioned the tools which are being used to make him a slave and to destroy him also from within. He cannot escape being muzzled by those who have political power in their hands. As a soldier he is forced to sacrifice his own life and to destroy the lives of others even when he is convinced of the absurdity of such sacrifices. He is fully aware of the fact that universal destruction is unavoidable since historical development has led to the concentration of all economic, political and military power in the hands of national states. He also realizes that mankind can only be saved if a super-national system, based on law, would be created to eliminate for all time the methods of brute force. However, the man of science has slipped so much that he accepts the slavery inflicted upon him by national states as his inevitable fate. He even degrades himself to such an extent that he helps obediently in the perfection of the means for the general destruction of mankind.

Is there really no escape for the man of science? Must he really tolerate and suffer all these indignities?

Is the time gone forever when, aroused by his inner freedom and the independence of his thinking and his work, he had a chance of enlightening and enriching the lives of his fellow-human beings? In placing his work too much on an intellectual basis, has he not forgotten about his responsibility and dignity? My answer is: while it is true that an inherently free and scrupulous person may be destroyed, such an individual can never be enslaved or used as a blind tool.

If the man of science of our day could find the time and the courage to think honestly and critically over his situation and the tasks before him and if he would act accordingly, the possibilities for a sensible and satisfactory solution of the present dangerous international situation would be considerably improved.

Text translated from the German by Dr. Ira M. Freeman of the Department of Natural Sciences of Unesco, and approved by Prof. Einstein.

Is scientific training enough for a man ?

by

LOUIS DE BROGLIE
of the Académie française and the Académie des Sciences

Science and applied science are becoming daily more important in the life of contemporary society. This trend will become more and more marked; in the intellectual sphere, the new ideas we owe to science, and the hitherto unsuspected possibilities it opens up, are bound to imbue a growing number of young minds and to exert a profound and lasting influence upon them; in the sphere of common daily life, the countless discoveries which have transformed and will increasingly transform the conditions in which we live are certain to arouse more and more interest, among the rising generation, in the movement of ideas which has made those discoveries possible.

It thus seems inevitable that the sciences should bulk ever larger in educational syllabuses and in the intellectual training of the young. Besides the fact that considerable scientific knowledge will be a necessary condition of access to a growing number of careers, it will no longer be possible to call any general education comprehensive unless it includes a broad picture of the development of the sciences and the achievements they have brought about. Thus the very basis of the methods employed to train the intellect will be profoundly modified. For centuries, the principal instrument used was classical humanism, or the study of the works of ancient Greece and Rome, leading on to that of more recent literature. The undoubted importance of classical thought as an initial source of impetus in the intellectual development of humanity, the profundity of the philosophical concepts it has bequeathed to us, the beauty of the works of art we have garnered from that distant past, and the example they have set us in the subtle analysis of sentiment, all warranted for many centuries the place so long accorded to this method of training the mind. But the inexorable passage of time is bearing us farther and farther away from that charmed dawn of knowledge and human sensibility; the need to acquire a great amount of knowledge undreamt of in past centuries is bound gradually to abate the ascendancy hitherto enjoyed by the classical education. An entirely new type of general education must progressively replace the old, and the classical humanities will inevitably find the place accorded them more and more restricted, while much attention will have to be devoted to the scientific advances which have revolutionized modern thought and so greatly extended its field, and to the needs of contemporary life, which compel so many young people sooner or later to apply their minds to various techniques involving science.

Since this is the inevitable consequence of a movement, indissociable from the progress of civilization, which it is impossible to moderate or reverse, some radical thinkers will possibly advocate basing the whole intellectual training of the young on the teaching of science, allotting to that teaching the privileged position formerly held by the classical humanities. I naturally cherish the deepest admiration for science in all its aspects, for the exactitude of its methods and the boldness of its theories, for the avenues of thought it opens up and for the benefits it may confer on men in their daily life and in the relief of distress. Nevertheless, I should like to explain briefly why I do not think that an exclusively scientific education can provide a nation with the full range of enlightened leaders in different fields, who are more than ever necessary at the present day.

The sciences are certainly of very great educative value. Not only is the study of science a preparation of various careers and various forms of technology in which science plays a fundamental part, but the general ideas and the new modes of thought with which such study furnishes the young, and the accurate and often difficult methods which it teaches them to apply, are of indubitable value in the training of the intellect. We are forced to recognize however, that not all young minds are able to assimilate with equal ease the pabulum it offers. Many of them, in particular, find it difficult to master the abstract processes of mathematical reasoning, whose use is becoming essential in more and more branches of science. Nevertheless, we may hope to interest even young people with little aptitude for science in the progress which has been achieved in the scientific field, and in the blaze or glimmer of light which scientific advances may throw on the mysteries of nature and the questions which have occupied men's minds throughout the ages. The history and philosophy of science might well be introduced into teaching in such a way as to reveal the grandeur of science and the importance of its discoveries, even to pupils whose natural bent is not for scientific study.

We may thus hope to succeed, if need be, by recourse to a few stratagems in teaching, in developing a sort of modern humanism, no longer drawing on ancient Greek and Roman culture, but based essentially upon the progress of our

knowledge of natural phenomena. It was surely rather by this method that the great schools of Greek philosophy came into being long ago. They had none of our sometimes unwieldy heritage of earlier learning behind them, and did not seek sustenance in an already ancient culture; they looked on nature with fresh eyes and sought to understand it by reflection. By doing so, they succeeded in setting problems an developing concepts or modes of thought which still today compel our admiration. Modern man, helped by the precision of the experimental method and equipped with far wider knowledge and far more elaborate methods, might travel still further along this road, bringing into being a new humanism, wider and more scientific than the old. This is a dream we may cherish: it may be one of the achievements of tomorrow. But, in my opinion, if this new humanism is to be complete and to fulfil its part in education to the utmost, it cannot be based solely on the acquisition of scientific knowledge.

Man, in fact, is not intellect and reason alone. Sentiment and will are also integral parts of his make-up. Thought, desire and action are closely intermingled in all he does. Pure ratiocination, excellent though it be, can never be self-sufficient, for our course is determined by our aspirations, and all our endeavours must ultimately lead to acts. If we were asked to place the three terms of the trinity of "thought, sentiment and action" in order of importance, we should probably have to award the first place to sentiment, for, when all is said and done, it is the motive power of all our thoughts and all our actions. Science itself, whether it be the pursuit of truth or the desire for power over the outer world to relieve distress or better our life, is ultimately dependent on sentiment or, rather, on desire, the desire for knowledge or the desire for achievement.

It is not enough to wrest her secrets from nature by the experimental method or to practise the manipulation of mathematical reasoning: we must also know ourselves. Any general education truly deserving that name must therefore always include, in addition to the acquisition of scientific knowledge, profound reflection on the complexity of human personality and its various aspects, besides the training of sentiment and will. That is the very essence of humanism and the true meaning of the word. Modern humanism, even if it is to be quite divorced from Greek and Roman culture, must preserve these characteristics and, for that reason, an important place must always be accorded to the study of literature.

Part of the aim and part of the effect of the study of literature is to teach the student to manipulate his mother tongue, or possibly foreign languages, with ease, and to appreciate the resources and refinements of language; this is a form of knowledge which is really essential in the present times, when, with the increasing complexities in every field, it is necessary to combine precision and fine distinction. Even in science, this need for a thorough and exact knowledge of the language used to convey all the subtle refinements of modern thinking is more apparent than ever before. But literary study has another purpose besides providing exercise in the proper expression of thought. It must develop sensibility, teach the analysis of sentiment, and reveal the hidden springs of action in the human soul. This is really the aim pursued, by different methods and from different points of view, in the study of literature in the strict sense, in that of history, and indeed in that of philosophy; the introduction to certain arts, such as drawing, music etc., may also help towards this end. Geography, though a science from certain points of view, from others is more directly concerned with man, and so associated with the literary side of education. Physical education and certain tests of endurance may also help to train the will. Thus we have a whole series of disciplines, whose educational value may be as great as that of scientific instruction proper, and without which it is impossible to train intellect, heart and will to the full at one and the same time.

To sum up briefly these few thoughts, the essential object of any education worthy of the name will, in the end, always be the comprehensive study of man, set, of course, against the background of his environment and the conditions of his life. It is hardly paradoxical to say that there is only one object of knowledge; our inner life. Everything we know must, in fact, come to us through our inner being, suffering refraction in its passage—thought or reasoning, sensation, sentiment or desire, decision or will to action, and science itself. For that reason, in my opinion, there can be no true culture which does not take in every aspect of human personality. A purely scientific education, which, by its very nature, leaves aside the deep sources of desire and will, can therefore never be enough. Classical studies may decline still further, the old forms of humanism may vanish; but whatever is put in their place must always include the study of the whole man; no human feature must ever be excluded and, for that reason, the foundation on which it rests can never be too narrowly scientific and technical.

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Scientific progress in the present-day world

by

PIERRE AUGER

We are living in a period which is agreed by everyone to be one of ferment, a period of change and crisis; but if we ask what view will be taken in, say two or three hundred years, of the importance of this period in the evolution of mankind, do you believe that the point attracting most attention will be this or that political change? I do not. I believe that this period will be regarded as the opening of a great new age in the history of man, the *scientific age*, which will take its place after the stone age, the iron age and the age of the great discoveries. The period of man's development beginning in the eighteenth century and continuing through the present period, which marks an extremely rapid ascendant phase, will be one of the great ages of our history.

If, as others have done from time to time, we compare the conditions of life in the time of the ancient Egyptians 4,000 years ago, and in the eighteenth century, we see that in spite of the considerable changes apparent to the superficial observer—changes in fashion and changes in customs—very little technical progress had been made. Building materials were the same: stone was used in the eighteenth century as it was among the Egyptians. Animals were still the only means of transport in use on land, while on the sea ships still depended on sails or oars. The production of energy was the same as it had been some thousands of years before. The torches, lamps and candles employed to give light were really based on the same old principle. Clothes were made of wool flax just like those to be found in tombs dating back to the third millennium before our own era.

On the other hand, if we compare the conditions of life in the eighteenth century with those of the twentieth, we find that there has been a very great change, which is becoming still more marked year by year and day by day.

The speed of this advance has been dizziest in the last 50 years. There is no means of measuring it, but we can arrive at a very rough estimate by considering the number of original publications, scientific books and articles which have come out each year. At the present time, nearly a million original scientific articles are being published throughout the world; not all of them are of superlative quality but they all have a certain contribution to make. I need hardly tell you that if this movement were to continue it would have extremely inconvenient results—and that the means of publication are fairly near saturation point. But we need not feel uneasy: science and technology will discover far more efficient and far more rapid methods than printing, with which we have been content, I would remind you, since the time of Gutenberg. New principles are in fact already being applied, principles which will bring about a profound change not only in methods of publication but also in the methods of distributing scientific works.

But why are we so greatly concerned with the question of scientific progress? Again and again we have heard people criticize the advances of science, labelling their effects dangerous, destructive and baneful. It has been said that science is constantly destroying or threatening delicate structures, painfully erected and only with difficulty to be preserved, such as the balance of society and the economic stability of the nations. Science puts new weapons of destruction into the hands of man. Science must be stopped, a moratorium must be declared. These people are prone to say that the Golden Age is past, and that if we may not make our way back, we must at least arrest a current which is carrying us farther and farther away from it. These people might echo the words of Gérard de Nerval: *"Ils reviendront, ces Dieux que tu pleures toujours . . ."*, the Gods for whom you weep will one day return. They want to turn back the clock, to return to the Gods they lament, but there is no longer any question of doing so, and no answer is called for; we are caught up in an automatic process, a natural process which we men are powerless to arrest. Instead of striving to oppose the laws of nature, we should be better advised to follow good scientific principles and turn them to our use. Moreover, what of the good that lies in this science which has, after all, so recently become a part of man's activities?

The most remarkable feature of science is, beyond a doubt, that it is an "increasing function" of time, constantly progressing. This seems quite obvious to us now, but, when we think of it, it is a very important point, for the study of science is the only intellectual activity of man of which this can really be said. No scientific acquisition is ever lost, and the sum of scientific knowledge at any given time contains, in one form or another, the sum of knowledge of every earlier period. Much as I

respect and appreciate the arts and literature, I cannot admit that those forms of man's intellectual activity display the same characteristics; so much talent and effort have been wasted in producing works which have proved ephemeral, either because the material was perishable, as with Greek painting or simply because fashions have changed and we can no longer find pleasure in their contemplation. There is no continuous progress in art, but rather a progressive exploration of the whole field over which man's imagination may roam. New movements in art are, moreover, quite as often—perhaps more often—due to rejection of the past than to its development.

The continuous advance of science makes it a wonderful spur to creative work. The scientist knows that he is helping to erect a fabric which must necessarily grow finer year by year; he knows that if he succeeds in laying even the most insignificant brick in its walls, it will survive for ever, firmly set in its place; if it is a good brick, however small, it will always bear some of the weight of the whole structure. And this certainty does much to satisfy the self-respect and pride of the fortunate research worker.

It is also a remedy against boredom and depression. It is probably unnecessary to stress this point in present circumstances, for in the times in which we live few people are bored. Yet every day, and particularly among young people, we can see signs of that malady which was once called *mal du siècle*, one of the many names given to the sudden realization that everything is repetition and that, when all is said and done, there is really nothing new in the world. It is unnecessary to do as Baudelaire proposed and seek for novelty beyond death; we need not have recourse to euthanasia; all we need do is to scan the current number of any good scientific review to find ideas and arguments which are absolutely new. When you open your daily paper you find the news, but, in reality, it is ancient history in a new dress; men still go on thinking about the disagreements which divide them in the same old way, whereas science brings us something that is really new.

Science, which thus brings fresh understanding to the student, also furnishes a means of influencing the outer world. It has the same significance for all mankind. In fact, while science is an "increasing function" of time, it has another absolutely fundamental characteristic—universal application. There is no science of this country or that, there is no French science distinct from American science. A scientific fact correctly observed, a theory capable of application, a calculation free from error, are the work of men, without further qualification. No other human activity has a similar automatic significance for all peoples and all civilizations; even art, however perfect, cannot be understood without training and practice. The artist's work may lapse into oblivion, but scientific truth compels attention by its very nature and no obstacle can keep it hidden for long. Moreover, if I may introduce a comment which is a little aside from my subject, the religions which, in the course of time, have reached the highest pitch of refinement, have realized the absolute barrier of dogma. They have accordingly removed dogma to a different plane, where it runs no risk of coming into conflict with the discoveries of science. And with that plane, where it may not set foot, science is not concerned.

The fact that science is thus of universal interest entails consequences whose influence on the future is absolutely incalculable. Since Science is the same in every land, we can all work together; the only condition required is that workers everywhere shall be able to communicate with one another. Scientists and research workers must be able to associate. You all know how important the Brotherhood of Learning has been in history. In the Middle Ages and the Renaissance its members communicated with one another by correspondence, visits and travel; the opportunities available were limited but sufficient to meet the needs of the period. Now, however, our resources are far greater; we have scientific journals, symposia, congresses, and arrangements for exchanging teachers and students, keeping the members of this select society, their numbers now legion, in close touch with one another. By all these means a common attitude of mind, inspired by the common goal of the advancement of science, is maintained throughout this society.

Any scientist who makes a discovery automatically brings help to all his fellows, that is to say, to other research workers and other scientists; discoveries are not made *against* the interests of other scientists but *for* them. This results in a sort of friendliness which generally bears pleasant fruit: specialists in any branch of study are always ready to welcome a fellow research worker. I myself am a physicist, specializing in the study of cosmic rays; I have travelled a lot, and am always glad to remember my experiences whenever, in the course of my travels, I have met fellow physicists or, more particularly, cosmic scientists. I know that if I approach the professor of physics in a distant university I shall find in him a friend, and that if he is also a specialist on cosmic radiation, he will be a brother!

These links are extremely valuable in creating an atmosphere of understanding between the nations. Meetings, congresses, visits from scientists, research workers and students are all factors continually helping to bring about such understanding. Here we have common ground whose value can hardly be over-estimated.

What an extraordinary contrast there is between the continual advance of science and the lack of change and development in man's hereditary characteristics. The species we dignify by the name of *homo sapiens*, of which it has hardly shown itself worthy so far, but which it is perhaps now about to earn, has not changed since the Neolithic period, that is to say, for the last 20,000 years. The capacity for learning and reasoning has remained unchanged; the only difference is to be found in education, which equips the young of today with all the acquired knowledge of their fathers, or at least, with that part which it is important for them to have; this new heritage of acquired characteristics is passed on by oral and written tradition, and that is the great novelty which man has introduced, since there is nothing comparable among the rest of living creatures.

This heritage, moreover, is uncertain and easily imperilled, since it is not incorporated in the very substance of the human germ at birth. It has to be passed on to the new generation as it develops. But, from another point of view, it is a sure and safe inheritance, being contained in a multitude of books in all the libraries of the world, including so many copies that it is impossible to imagine the sudden and total destruction of all.

If the human species were to disappear in some cataclysm, leaving only a pair of uneducated savages who had taken no part in present-day developments, it would be necessary to start again at the Neolithic epoch; in other words, it would probably take another 20,000 years to get back to the stage we have now reached. If, on the other hand, a pair of adults, or even a pair of adolescents who had received the usual secondary education, were left, it would take only a few generations to regain the present state of knowledge. This comparison demonstrates at once the solidity and the frailty of this structure. Man himself has not evolved, his potentialities are still the same; but society, as the result of evolution, makes an infinitely better use of those potentialities now than it did a few thousand years ago.

This also shows that only the acquisitions of science count in this evolution, for there is no need to demonstrate how frail the acquisitions of morality may prove, real though they be, when circumstances put them to too hard a test.

Perhaps, then, we can better understand the fervour of those who devote their lives, and sacrifice all, to science. Perhaps we can better understand why they try to open up the path to as many of their fellow-citizens as possible and why they base all their hopes on the continual advance of science, since it alone can furnish anything truly new. "There is no new thing under the sun," said Ecclesiastes, but he was speaking of events on the strictly human plane; he could not foresee the developments of science; incidentally, no one can foresee them, for they are not a repetition of the past. Man is continually outstripping himself. There is no need of the Superman to be grafted on to decadent humanity, as proclaimed by Nietzsche. The future lies before man as he is and it rests with him to retain the mastery.

Extract from a lecture by Professor Pierre Auger, Director of the Department of Natural Sciences in Unesco, at the Palais de la Découverte, *Paris, on* 21 *October* 1950.

The technology and geography of energy

by

MAX SORRE

Skill in harnessing growing masses of energy, not only in their most immediately palpable forms, but even in their subtlest manifestations and the ability to mobilize and apply them for definite purposes, were early and valued privileges of our species. At the dawn of time, the use of fire was seen both as a means of self-preservation and as an irresistible weapon in man's competition with the animal and vegetable species. Having conquered space, he was enabled by fire to leave a deep mark on the Earth. Throughout the ages, but more especially during the past century and a half, and more rapidly during recent decades, the mobilization of hidden reserves and the rational—instead of, as hitherto, the empirical—use of the forces at large in air and water, have enabled him to achieve new triumphs over matter. The progress of scientific knowledge, opening new vistas on the actual constitution of this matter, justifies far-reaching hopes. Each success in the field of energy represents a victory over the resistance offered by inanimate objects and over the obstacle of space; it thus concerns the geographer.

Let us first consider what happens to the solar energy which constantly reaches the earth. The greater part of it is in the form of solar radiation, and of this, a considerable part is retained in the atmospheric envelope. Of the fraction which reaches the ground, a certain quantity is returned to the air in the form of reflected heat. The unequal distribution of direct rays and reflected radiation according to latitude and other geographical conditions generates currents in the gaseous mass. In this way, solar heat is transformed into energy of movement which can be utilized by men (winds). Unabsorbed, reflected, direct or diffused rays are the starting point for a number of cycles. Some of these rays are absorbed by plants and may be found in three principal forms in our total energy consumption: in the living force of man, who, in the last analysis, lives on vegetable matter, in the domesticated force of animals, which, though unable themselves to absorb solar energy, derive it from the plants on which they feed, and in the carbon absorbed by plants, which in course of combustion, gives back the energy absorbed. Chemical energy intervenes only momentarily in these various cycles. As regards the rays which fall on the surface of the seas and oceans, these cause intense evaporation, and, after an inverse process of condensation, the energy thus generated is once again available to man in the vital force of running water. This sketch does not exhaust the possibilities. In the first place, many of the direct rays are dissipated in the form of diffused rays and remain unused because we have not the technical means of tapping them. Secondly, the differences in the temperatures reached by the various ocean layers create a potential whose value we are only beginning to understand. There is also another form of cosmic energy, regarding which we are slightly less incapable, namely the force released by the daily movement of marine waters in obedience to the moon's attraction (tides).

All these cycles, and in particular the biological cycle, have been in continuous operation since life first appeared on Earth, that is to say, throughout a period of which the existence of humanity constitutes but a short phase. Unceasingly, at the death of any member of the animal or vegetable species, the corpse's decomposition under normal conditions, that is to say, given the presence of air and a suitable temperature, has restored to its surroundings the energy accumulated in its tissues. On occasion, however, the piling up of organic remains protected from air has hindered the process of oxydation. The cycle having thus been cut, stocks accumulated in the strata of sediment in the form of coal or of gaseous or liquid hydrocarbons. These subsisted as long as later erosions did not penetrate the protective layers and destroy their integrity. Sometimes they disappeared, carried away with the inorganic layers by the action of water. Yet what remains of the stocks prepared for us by nature is still considerable in relation to our needs.

The time is not long past when this sketch of the transmutation of solar energy would have been sufficient, merely mentioning as a minor source the energy produced by the heat of our globe, which is protected from our onslaughts by the poor conductibility of its crust. And a brief allusion might have been made to other theoretical possibilities: not only to those mysterious cosmic rays whose action can be discerned in inland waters to a depth of 230 metres, but also to what might be called the dynamic equivalent of matter. Whatever could have been said about the amount of energy represented by a piece of granite was pure conjecture. But as a result of the rapid extension of our knowledge of radioactivity and nuclear physics, this is no longer so. Now we see every atom of matter as a source of energy which could be liberated by

splitting that atom. The energy released by the destruction of the nucleus would be proportional to the disintegrated mass, and the nuclear reaction would be comparable to the burning of carbon at the molecular level. Inexhaustible supplies of energy are contained in atoms: the energy obtained by the destruction of 500 grammes of any matter—be it stone, feather or metal—would be equal to the output of all France's power stations in one year. These are neither dreams nor even purely theoretical questions. Since Becquerel's discovery on 24 February 1896 and the work of the Curies, the utilization of the spontaneous radiation of radium has become a part of medical practice. Advancing still further, a series of brilliant researches into nuclear physics, among which those of Joliot-Curie must be given pride of place in France, have led to the splitting of the nucleus of a special substance such as uranium, thus suddenly releasing a large amount of energy. This was immediately used for destructive purposes. And humanity, no longer master of its actions, stands hesitant, perhaps even terrified, before the new possibilities offered to it by science. Science itself is not responsible for the uses to which it is put. Nevertheless, those possibilities do exist, and the imagination is staggered by the new horizons opening up before us.

In what follows, we will confine ourselves to the cycle of energy produced by solar rays. The energy derived from splitting the atom is not yet being used for peaceful industrial purposes. Not that it does not yet appear to be thus usable. For a source of energy to be usable, two conditions must be fulfilled. Production itself must be worth-while in terms of energy; this is so in the case of the uranium nucleus, owing to the chain of reactions set in motion by splitting it. And, in addition, the energy must be produced in a manageable form, that is to say, under conditions which make it possible either to utilize it in our transforming apparatus or to stock it for use as required. This second condition did not at first seem to obtain owing to the suddenness with which atomic energy was released. Let us draw a comparison: for centuries, men have been using the breaking power of powder and other explosives for warlike or peaceful purposes; but they have not yet succeeded in making an engine run on dynamite. However, the speed at which physics and applied physics are progressing justifies great hopes: something more than hopes, indeed since reactions can already be slowed down. Yet we have not reached the period of full adaptation, however close it may seem.

To return to the classical sources of energy, those used in practice at the present time are: (1) the live force of winds, water courses and, to an insignificant degree, tides; (2) the force of living beings; (3) fossilized energy. The first reaches us in a continuous stream, and its volume remains unchanged, however much we take from it. It is inexhaustible. The second is not available in unlimited quantities, but can be built up afresh, given a suitable interval of time. It is for us to regulate its use in relation to its renewal rate. We call it renewable. As to the third, we call it exhaustible because, no sooner is it within man's reach than he destroys it, without hope of replacement. Its formation has been very gradual, at a pace wholly unrelated to that of our own activities. Any economy based on its use is by definition a destructive economy.

Physicists, engineers and economists have all endeavoured to compute the amount of energy actually available for the needs of mankind, taking into account only classical sources. Perhaps one day people will cease to take an interest in these calculations; for the present, however, they are still fascinating. Sometimes they are barely comprehensible to the average mind. When a theoretician like Svante Arrhenius adopts a million calories as the unit for measuring solar radiation and its transformations, and expresses that radiation in terms of 3, 10^{12}, 10^{3}, all we see in the first place are numerical symbols devoid of real meaning. If, however, using the Scandinavian scientist's tables, we can say that the atmosphere transmits to the earth only 38.6 per cent of the rays which reach its confines, that the atmospheric currents absorb 2.4 per cent of them, and the evaporation of water 25 per cent —together 66 hundredths of the energy which reaches the earth—and that only about 1/5000th of the latter is used by plants, then we feel that we are getting back to the realm of the intelligible. But what, despite their author's authority, is the value of such clearly speculative data? We feel ourselves on safer ground if we limit our research to the forms of energy most frequently used, basing ourselves on the most directly available facts and reducing the margin of extrapolation to a minimum. What is the value of estimates of hydraulic force and stocks of fossilized energy made in this spirit? A complete list of the live forces of watercourses in the best-known regions of the world still leaves scope for variations in the assessment of usable supplies. There is no method of directly measuring the reserves of liquid hydrocarbons. Even in estimating reserves of the least unknown solid fuels, there may be divergencies due to our ignorance of deep-seated and inaccessible layers, to the lack of precision in published statistics which do not always sufficiently take into account what can actually be mined, and to the frequent confusion between fact, possibility and probability. Where the Toronto Congress of 1913 put the total at Tm 7,397 milliards, the World Power Conference put the figure at only 5,835 millions, while in 1924, Dr van Heys gave it as 10,000 milliards, and the Moscow Congress of 1937 as 7,876 milliards. As Dunlop has said, the differences are far too great for these figures to have any value. We shall therefore abandon any

attempt to produce an overall estimate, reserving the right to make use of the most recent corrections of the most probable partial results.

The task will be simplified if we eliminate extrapolations and restrict ourselves to the amounts of energy actually employed. Clearly, there is a tremendous consumption of timber for heating, of hydraulic energy in small concerns dispersed throughout the world, and of wind energy, on which no check can be kept. The relative importance of this consumption diminishes as statistics are perfected, but it is still considerable.

Another difficulty is to assess in terms of energy all the forces used. A ton of coal is not the same thing as a ton of lignite. Two tons of lignite from two different coalfields have not the same calorific value. And energy coefficients are not always applied with sufficient care. Nevertheless, great progress has been made by publications such as those of ILO, the *Institut für Konjunkturforschung* and the World Power Conference. The following table of world energy production is taken from the Institute.

	PERCENTAGES						TOTAL (10^{15})
	Coal	Lignite	Petroleum	Nat. Gas	Timber	Hydr. power	in thermic equivalents of coal
1913	71.4	2.7	4.5	1.4	17.6	2.4	1703
1935	56.5	3.7	16.5	3.8	12.8	6.6	1964

Consumption in 1935, which marked the end of the crisis, was lower than in 1919, which was the highest on record before the last war (2,129). Leaving aside these very marked variations, due to the recurrence of trade cycles reinforced by the incidence of political events, it appears that energy consumption increased 20 per cent from 1913 to 1925, and 15 per cent from 1929 to 1935, which is 0.68 of the earlier annual consumption. There is no reason to suppose that this proportion will be maintained. There are in fact two influences apparent in the curve: a continual upward trend, stimulated by the multiple uses to which energy can be applied and the increase in available resources, and, conversely, the saving of energy resulting from technical progress, stimulated by the prospect of exhaustion of certain sources. We shall revert to this in our conclusions. The percentage curves show remarkable continuity and are independent of the general consumption curves. The general features of this development are: overall reduction in the proportion of energy derived from coal, compensated, and even overcompensated, by the increased importance of petroleum and natural gases and the almost threefold increase in the proportion of hydraulic power in the total; the picture that emerges is of a mass of complex phenomena having a considerable potential influence on geography.

Before concluding these remarks on utilized energy in general, we may note that the mere accumulation of metric tons at the mineheads or of kilowatt hours at the hydro-electric terminals is not enough. Whatever the energy cycle, there remains the question of the machine's ability to use the potential supplied to it and to derive from it the maximum utilizable power. Output is the relation between what the machine produces and what is fed to it, between useful energy and expenditure, Tu/Tm, and this concept applies to living engines as much as to others. If we consider only machines in the strict sense of the term, the differences in categories and the rapid variations of output are striking. In 1917, Steinmetz based his calculations on an output of 10 per cent for engines using solid fuels. This coefficient has since been exceeded, and it will be necessary to revise his figures and bring them up to date. But that is not all. The amounts of energy which an engine can produce vary according to its type in increasing proportions, from the quantity produced by a man to that produced by a large modern power station. But until quite recently, humanity has had, absolutely speaking, only weak or medium-powered engines at its disposal. There is no disadvantage in this when work is dispersed so that only small amounts of energy are required at any one point. The situation is different in the case of large-scale workings requiring great quantities of energy. Hence, in addition to energy supplies, we must consider the possibilities of concentrating work. It is this which governs the problem of location.

Men use the available power in only very few forms: mechanical, calorific, luminous, chemical, sonorous and electrical—not to mention more recent forms. The expenditure of mechanized and thermic energy is related to the basic needs of industry. The former has been directly derived from the utilization of the muscular activity of men and domestic animals; the study of living energy and of the work of human beings or animals is one chapter in the geography of energy. Quite early, other natural sources were also used, both actual and potential, such as fire, wind or river currents. The most recent stages of technical progress are typified by electric power. In England, the home of the steam engine, the utilization of electric power increased by 900 per cent between 1907 and 1930, while the proportion of mechanized power diminished by 13 per cent. This is because electric power is an aristocrat of energy, on account of the uses to which it is put and the ease with which its output can be automatically controlled. But it always results from the transformation of mechanized energy of hydraulic or thermic origin.

The idea that the different forms of energy can be transformed from one to another, that man can become the master of their production and their metamorphoses, apply them at will, concentrate their diffuse power and make them manageable, was given practical application only very late in the history of our species: indeed,

only yesterday in terms of geological or even prehistoric time. The invention of fire, the first stages in the use of implements, and, much later, the harnessing of energy, once its essential unity under the diversity of its appearances had been grasped, all these are capital events in the history of humanity. The marks they have left on the evolution of our planet continue to exist side by side. And it is this co-existence of phenomena pertaining to different periods in the technology of energy which is one of the sources of variety in the geography of Man.

These are the considerations which govern the geography of energy. Three themes will constantly recur in our survey of these essential phenomena: the harnessing of energy, its utilization in the most appropriate forms and the removal of the site of production to the site of consumption. Almost every specific question hinges on one of these, and this general survey provides a clue.

Extract from Les fondements de la géographie humaine *by Max. Sorre, Professor at the Sorbonne. (Vol. II: "Les fondements techniques", Part I). Published by Armand Colin, Paris.*

Electricity, the decisive factor in modern civilization

by

EDMOND ROUX

The applications of electric power, which has been used for practical purposes only since the close of last century, are not confined to a few types only of human activity. This powerful, adaptable, immaterial form of energy has everywhere made its influence felt and has gradually become one of man's essential allies, silently revolutionizing his living and working conditions.

The term "revolutionize" may appear hackneyed, since it has already been applied to so many of the discoveries so characteristic of the present age. In particular, there is no denying that the steam locomotive and the internal combustion engine have completely transformed the old methods of transport by land, sea and air.

But, without wishing to belittle their influence, we must acknowledge that these discoveries usually affect only a limited field and that their consequences, however important, are not of universal scope. For instance, without prophesying, it is legitimate to suppose that for some time yet the air routes will be used by only a minority of travellers.

The discovery of electric power, on the other hand, has had universal repercussions, and its applications are continually becoming more widespread and more varied. Already, the great bulk of the population of civilized countries enjoys its benefits, which are constantly being extended. In the home, the workshop and on the farm, an increasing number of important uses are being found for this new form of energy, which has brought about far-reaching changes in our daily lives.

Not only has it given man more than 10 times his former strength, skill and capacity for work, but new prospects have been opened up by many inventions based on electric power, an inexhaustible fount of amazing possibilities: telegraphy and the telephone, films, radio and television.

Electric power may thus claim to be an essential factor in civilization, for its influence extends to every field of human activity, to every aspect of life, whether material or intellectual.

Since prehistoric times, when his own physical strength was all man had to rely on for supplying his essential needs, he had already gone a long way towards subduing the forces of nature. Ancient history shows us that the domestication of animals and the invention of a few simple machines such as the lever, water- and wind-mills and chain pumps had progressively lightened his labours. These different methods still survive to some extent, particularly in rural areas, where animal traction is largely used even today.

Although the peasant prefers to cling to the traditions of his forefathers, some branches of economy have for more than a century now been marked by far-reaching changes in the utilization of motor power. The tremendous expansion of industry that began in the early nineteenth century is due to the appearance of the steam engine, which converted the workshops of the past into modern factories.

However, the scope of steam and of such new sources of energy as gas, petrol and heavy oil, despite their intrinsic power, was strictly proportionate to the effective distance to which it could be transmitted by belts and shafting.

A steam locomotive, for instance, has to carry with it the coal and water required for self-propulsion, where an electric locomotive draws its energy from stations that may be hundreds of miles away, wherever is most convenient.

These forms of energy could thus never bid for first place, as they lac?ed such characteristics as universality of application, infinite divisibility and convenient transmission at all times and places, which were to be the distinguishing features of electric power.

At the outset, journalists who had to describe the so-called wonders of electricity, more particularly at the World Exhibition in Paris in 1889, where it first won fame, christened it "fairy electricity"; and no name could have been better chosen, for its achievements often savoured of magic.

When we think of the advantages it brings to a home well equipped with electrical appliances, we are reminded of that charming legend in which the all-powerful fairy, wishing to bestow every blessing on her favourites, conjures up with her magic wand a host of unwearying

sprites to perform every task, from the simplest to the most irksome.

The electric lights, cookers, irons, vacuum cleaners, refrigerators, washing machines and wireless sets that have become part of our everyday life; what are they but devoted, tireless sprites ever at our beck and call, lightening the burden of domestic work and bringing brightness and comfort to our homes?

But apart from these familiar sprites, there are the powerful, docile giants which in every kind of industry have taken over the heaviest and most difficult work, such as the concerted efforts of thousands of men would be powerless to perform. Rolling mills which, amounting to several thousand horse-power, need only a few passes to transform a shapeless block of steel into a calibrated rail, the hoisting machine set up at mine-heads, that take no time to extract the precious coal from the bowels of the earth, and travelling cranes which, with their relentless arms, clutch and raise the heaviest of loads as if they were straw, are all permanent witness to the omnipotence of electricity.

We must not overlook electric traction, for, although it did not revolutionize transport, it yet possesses many solid advantages over steam traction: cleanliness, healthiness, rapidity, economy and adaptability of transport, not so speak of the uses to which steam traction has never aspired. We only need to think of the tremendous traffic load carried with admirable ease and regularity by the underground networks in the world's leading capitals. No other form of energy would have been suited to the special conditions of such heavy underground transport.

Electricity has to such an extent become part of our daily lives, entering even into our reflexes, that we now accept its wonders unthinkingly.

No sooner has one of our desires crystallized into consciousness than it can be fulfilled by an effortless and almost automatic gesture. At any hour of the day or night, in any place, we have only to beckon, and a slave instantly answers our summons and carries out our behest, faultlessly and ungrudgingly.

Would the master of these obedient slaves like to have a little more light, to hear the Ninth Symphony performed by an orchestra in New York, to learn the rates on the Amsterdam Stock Exchange, to be carried in a lift, to set in motion the tiny motor of his razor, or the powerful locomotive of an express train? He has only to put his finger on a switch and immediately the kilowatt-hours hasten, swift as thought, to gratify his every wish. Along hundreds of kilometres of electric lines, an intricate system of relays and engines has been set in motion, steam or water valves have opened where necessary at the silent bidding of an invisible major-domo, and the orderly band of sprites is at hand to serve man's will. The legendary dream, the hope nourished by mankind from earliest times, has now come true in a more wonderful way than could ever have been imagined.

Extract from Energie électrique et Civilisation *by Edmond Roux (Bibliothèque de philosophie scientifique, Flammarion, éditeur, Paris).*

Man's use of energy

Symposium held at the Science Congress in Salisbury, Southern Rhodesia

At the recent Science Congress in Salisbury, Southern Rhodesia, a symposium was held on "Man's Use of Energy", this topic having been suggested by the United Nations Educational, Scientific and Cultural Organization (Unesco) as one for world-wide discussion. The importance of the subject need hardly be stressed for, as Dr. D. F. Kokot pointed out in discussion, the old concept of limitless resources in a scantily populated globe has gone and the present picture is one in which the exhaustion, or serious depletion, of a large range of expendable resources is actually in sight, especially if the present rate of growth of the world's population is maintained.

In the field of power resources the present rate of consumption of natural fuel is anything but reassuring and it is becoming increasingly important that we should turn our attention to some of the inexpendable resources such as tides, flowing rivers, wind and solar heat. In our present state of development the most important of these, according to Dr. Kokot, is, undoubtedly, that provided by the flowing waters of rivers. Indirectly this power comes from the sun, which provides the energy for evaporating moisture and converting it into clouds. The potential energy of the rain water falling upon the area of the Union of South Africa, for instance, is about 100 times as great as the Union's power consumption, but if only the fraction which flows in rivers could be harnessed it would provide about four times the Union's present power requirements. Unfortunately, conditions in South Africa are such that very little of this immense energy resource can be usefully employed, mainly because the water is urgently required for other purposes.

Although the Union is so poorly placed with regard to the generation of power from her rivers, other areas in Africa are richly endowed with rivers which can be harnessed.[1] The Congo has a catchment area three times the size of the Union and ranks second only to the Amazon in the volume of its flow. The Nile is one of the major rivers of the world and the Niger is also a stream with an enormous catchment area and good flow. Nearer home, the Zambesi dominates the scene and several plans have been proposed for making use of its energy, preferably without damaging the beauty of the Victoria Falls. Until very recently, however, these schemes have been ideals rather than practical proposals.

Within the past few months it has been decided that a scheme for damming the Zambesi at the Kariba Gorge should be proceeded with, and the plan was explained by Mr. P. H. Haviland, Director of Irrigation for Southern Rhodesia.[2] Preliminary investigations have been in the hands of an Inter-territorial Hydro-electric Power Commission representing the Governments of the two Rhodesias and Nyasaland, the collation and interpretation of the data collected being carried out by the Commission's Civil and Hydrographic Engineer.

The drainage area of the Zambesi, excluding the negligible contribution of the Quando River, is 460,800 square miles in all and 203,000 square miles of this lies above the proposed dam site near the lower end of the Kariba Gorge. The gorge is 900 miles from the source and about 750 miles below the Victoria Falls, which remains unaffected. The grade in the gorge area is low and it is necessary to construct a dam approaching 400 feet in height at or near the exit of the gorge in order to provide sufficient head of water for power development. The storage capacity will be about 70 to 90 million acre feet, capable of a continuous discharge sufficient to develop continuously 600,000 or 700,000 kilowatts. The total area of the reservoir will be about 1,600 square miles and the lake will be 180 miles in length and average 10 to 15 miles in width.

The cost of the dam is estimated at about £15,000,000 sterling and an approximately equal sum will be required over a number of years for the various power units and the 200 mile long transmission lines. It is likely that generating groups will be installed in sections, each developing 150,000 kVA, as load requirements necessitate, and six or seven such groups will ultimately be erected. Fortunately a number of large rivers enter the Zambesi below Kariba Gorge and consequently other power projects will be possible in Portuguese territory before the river enters the sea.

While Rhodesia will ultimately derive great benefits from the harnessing of the Zambesi, South Africa is likely to have to rely chiefly upon coal for the generation of electric power and a contribution by Dr. G. N. G. Hamilton on coal and derived fuels as a source of energy gave the heartening information that the resources of South Africa in this respect are so large that their

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[1] See *South African Journal of Science*, 46, pp. 319-320.
[2] The full account appears on pp. 77-79 of this issue.

exhaustion may take many centuries. The present annual production is about 30 million tons (two-thirds of which comes from the Transvaal), some 7 million tons of it being used for generating electric power. A rapid increase in consumption may be anticipated owing to a number of factors, including the pending establishment of an "oil from coal" industry. An increase in exports also appears likely as the Union can provide good quality coal at competitive prices and is strategically situated for export to other parts of the Southern Hemisphere which are short of coal. Most South African coals are of the semi-bituminous variety but smaller quantities of coking coals are also found, chiefly in Natal. Semi-anthracite coals occur in moderate quantities but true anthracites are not known. Much of the coal is very suitable for use in oil distillation, but research is needed to discover wider uses for the semi-anthracites and for the plentiful low-grade coals. It is also necessary that, in spite of the very large reserves of many thousands of million tons of coal, wasteful misuse and the loss of potentially very valuable by-products should be prevented at an early date.

Although coal and water are at present the principal media for generating electric power and oil is the chief fuel for transport energy, atomic sources are likely as Dr. A. E. H. Bleksley pointed out, to assume an increasingly significant role in power generation. There are difficulties still to be overcome in disposing of the dangerous radiation created in a generator such as the atomic pile used in making the artificial element plutonium, but there is no doubt about the tremendous quantities of heat liberated in the pile and potentially available for steam-raising or other purposes. A large American river had been employed to cool one pile system and the temperature of the entire river was raised to a point such that fish could not live in it, thus making it necessary for the water to be cooled before it was returned to its channel. One ton of uranium, for example, would produce about the same energy as 10 million tons of coal and could thus provide all the Union's electric generating requirements for more than a year. One hundred and fifty tons of fissionable materials could provide the world's major needs, thus freeing coal and oil to a large extent for chemical uses and purposes where atomic energy was inapplicable. Naturally the production of radio-active materials only from rich sources would have to be replaced by the exploitation of low-grade deposits, uranium and thorium being actually about as plentiful as tin or silver.

Other sources of energy which are at present almost neglected were also touched upon by Dr Bleksley. Wind is used to a limited extent for pumping borehole water and to a lesser extent for charging accumulators for radios. The generation of electricity on a larger scale is practicable and one unit with a capacity of about 800 kilowatts has been built in America to supply a small farming community. A steady wind of between 10 and 30 miles an hour is required for best results and there should be few calm days or gales. Such areas certainly exist but little or no research has been done to exploit their characteristics.

Wind is an indirect product of solar radiation, as also are water flow and the plant growth which gave rise to coal, but few attempts have been made to use the sun's energy directly. A power plant of small size was built experimentally in Egypt before the war but has not been developed. Many small "home-made" sun motors and heaters have doubtless been employed from time to time but the problem has not really received sufficient attention and deserves to be more fully studied. The amount of energy available is astounding, for the sunlight falling on a mere one square yard is equivalent to about half a horse power and the energy falling on one square mile of sunlit veld amounts to about one million kilowatts—the equivalent of the potential power output of the Kariba Gorge project. Furthermore, sunlight is an inexhaustible resource and its employment for power purposes will surely some day add its quota in man's use of energy.

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PART TWO

Energy in the Service of Man Abstracts

I. *General*

230 BLONDEL, F. "La conservation et l'utilisation des richesses minérales du monde." *Revue de l'industrie minérale,* January 1950.

The author, who was sent by the *Direction des Mines* to represent France at the United Nations Conference on Natural Resources, held at Lake Success from 17 August to 6 September 1949, explains the object and organization of the conference, the situation as regards world consumption of mineral products, and possibilities in the way of improvement. Given the current rate of consumption and present prices, there is no need to fear that mineral wealth will be exhausted in the immediate future. The problems arising bear mainly on the great inequality in the distribution of mineral wealth and the difficulties connected with extraction and transport. The problems are moral, economic and political.

231 CHAMAYOU, H. "Considération sur le bilan énergétique de la France et sur la place de l'énergie électrique dans ce bilan." *Revue générale de l'électricité,* December 1945, Vol. XIV, pp. 381-4.

As there are no statistics concerning the consumption of certain fuels, the balance sheet of France's power resources has rarely been compiled. That of 1938 shows a moderately industrialized country doing very little to expand its industrial equipment. The needs of the post-war period are tremendous: not only must more coal be extracted and more imported but more hydro-electric power must be harnessed. At present, it would be well if the idea of "financial return" could give place to that of "return in energy".

EGERTON, Sir Alfred. See No. 255.

232 GARRIGUE, R. *Les vues essentielles sur la politique française de l'énergie en fonction du plan d'équipement national.* Paris, *Délégation générale à l'équipement national,* 1944, 17 pp.

This report, which was occasioned by the deficit in the production of power, after giving certain data concerning France's consumption of power during the period preceding the second world war, contains a study of the prospects of increasing production from French sources of energy (coal, hydraulic power, substitute petroleum and fuels, firewood), and of using these different forms of energy more rationally. The report closes with a balance sheet of France's resources in energy (production-consumption) in 1938, as well as a table showing the distribution of consumption for each form of energy and for each type of use (transport, industry, etc.).

233 GEORGES, Pierre. *Géographie de l'énergie.* Paris, Librairie de Médicis, 1950, 470 pp., 38 figs. and maps, 28 plates, diagrams and tables.

A study of world energy from the dual angles of production and consumption. The work's object is not merely to provide information on the production of coal, oil and electric current, but to study operating conditions and, in particular, ways of using these forms of energy. The geography of energy indicates, at the national or regional level, the various economic and social structures. Its precise analysis of production and consumption in the different countries, and of the share or profit of the various social classes in each country, gives a clearer picture of the contemporary world. The study of the distribution of energy consumption touches on a great many economic and social problems, since the use of energy is the basis of the most varied material civilizations (from slavery and animal traction to nuclear energy), and can lead to both emancipation and servitude of every kind. The creation of a new system of energy gives fresh importance to countries or areas possessing material sources of that energy. The world is divided into geographical units which have achieved to the most modern forms of mechanical energy production and consumption, and others which are still unable to obtain or utilize them. To this great division, which was the outcome of the nineteenth and early twentieth centuries, there has now been added another, that of prospects in atomic energy. These purely technical and economic distinctions have political and social consequences (the individual appropriation of energy is a means to social domination). These are some of the conclusions reached by this geographical study of energy, which is thus shown to be one of the most penetrating ways of analysing the economic, social and political systems of the present-day world. The second part of the work, "The consumption of energy", directly corresponds to *Impact's* programme, with its dissertations on the consumption of, and trade in, energy in the industrial economies and the backward economies.

234 JARRIER, M. L. "La France devant le problème de l'énergie." *Annales des mines,* April 1947, pp. 6-30.

A general study of the production and use of the various forms of energy in France, different schemes under consideration or being carried out, general observations, comparison with other countries. The conclusions bring out the need for avoiding any waste of solid fuels, for improving the return from various types of solid fuels, for replacing a "scarce" energy source, wherever possible, by a less scarce source, and for making full use of all possibilities at present neglected, starting with those which are simplest to utilize (low-grade fuels, hydraulic energy, windpower). Generally speaking, the prospects for the future are encouraging.

235 LAILLET, Michel. *La conquête de l'énergie ou le progrès de la puissance humaine.* "Bibliothèque du peuple," Paris, Presses universitaires de France, 1941, 64 pp.

The history of human evolution, from the standpoint of the use and transformation of natural forces by man: fire, animals, wind, water-wheel, steam-engine, water-power, electricity and oil.

236. LAMBERT, Max. *Structures et problèmes des grandes industries françaises. Cours professé à l'école nationale d'organisation économique et sociale.* Paris, Presses universitaires de France, 1945, 373 pp.

The first part of the work deals with the problem of energy. Energy is, and has in all periods been, the indispensable raw material for everything created by man. Our own age is characterized by a tremendous increase in power, which enables the various sources of energy to be used to an ever-increasing degree. A study of their role involves, to a considerable extent, a comparative study of the various aspects of economic and social life. To go back into history and follow the evolution of the forms and manifestations of energy at different periods means encompassing, in its main features, the whole history of civilization's progress. The research programme thus defined in the early pages is followed by a study of energy in the world (its sources, and world reserves) and, in greater detail, in France (balance-sheet of resources, role of the various types of energy, needs, shortages). The problem of energy can be used to explain the structure of the great industries and their operational problems, which is the main object of this series of courses: the coal industry and its technical and economic conditions, the British, American, German, Russian and French markets, the questions of distribution, of consumption, of labour, of legislation, etc.; the iron and steel industry and its technical and economic conditions and markets; the engineering industries and their conditions of production, their organization and markets, etc.

237 MAJORELLE, Jean. *"L'économie de l'énergie." Les cours de droit*, Paris 1947, 3 vols., duplicated, 204 pp., statistical tables.

A course of lectures given at the Institut d'études politiques of the University of Paris during the school year 1946-1947. It is a general study of energy throughout the world, its sources, production, reserves and consumption. Solid fuels (deposits, legislation, industry, prices, sales methods, utilization), hydrocarbons, natural gases, petroleum (prospecting, exploitation, reserves, transport, legislation, consumption, etc.) and electric power (sources, transport, distribution, etc.) are dealt with in greater detail than the question of nuclear energy, which is only lightly touched upon. Energy is the basis of the power of nations. The policy governing its production and use, the choice between the different sources available, equipment, distribution and price-fixing are essentially matters for the State to determine. If, in the case of a country which has few sources of energy, the national sources which are capable only of a poor output are exploited on the pretext of economic self-sufficiency, this influences the manufacturing costs of the industries and the standard of life of the inhabitants. It would be better to import energy and counterbalance this expenditure by exporting products supplied by the labour and intelligence of the citizens of the country in question.

238 MAJORELLE, Jean. *La France devant le problème de l'énergie.* (Lecture given on 10 March 1948 before the Association française des techniciens du pétrole). Paris, Imprimerie J. Marx et Cie, 1948, 31 pp., tables.

The French problem as part of the general problem of world energy resources. Study of the role and evolution of each source of energy, excluding secondary sources (animal traction, wood, wind, the thermic energy of the seas, and nuclear energy), with an attempt to discover the amount of driving-power which each source of energy can effectively supply. A world balance-sheet calculated on this basis shows that, whereas the United States has 2,000 milliard kilowatt-hours per year for a population of 140 millions (i.e. 15,000 kWh per inhabitant), France has only 77 milliards, i.e., 28 times less (1900 kWh per inhabitant). Study of the evolution of coal, hydraulic power and oil in the world and in France, especially during recent years. In France, an impoverished country, the prime consideration in energy policy must be *yield*. National production must also be developed and one must not be afraid to import energy, especially oil, which would enable industrial production to be increased and improved.

239 MARTY, Henri. *Energies perdues, essai de synthèse sur les problèmes de hiérarchie et de rendement des énergies exploitées.* Toulouse, Editions toulousaines de l'ingénieur, 1948, 62 pp., bibliography and addenda.

Large amounts of energy are for various reasons deflected from their proper use. Defective organization, superfluous stocks, or over-production due to lack of standardization all mean losses of energy. Intelligent savings could increase man's well-being and leisure. A study of losses in the use of coal, gases, liquid fuels, electricity, etc. shows that, in certain cases, more than 90 per cent of the energy supplied in a complete cycle has been lost. Selection of the energy to be used, technical improvements and the rationalization of work would enable this to be remedied. It is not merely a question of harnessing ever-greater quantities of energy and of finding new sources; it is at least as important to co-ordinate and rationalize their use. *Organization* is the essential factor in the fight against waste of energy.

240 PENICAUD, M. *Structures démographiques, économiques, énergétiques de la France et de l'Allemagne occidentale (au cours des 25 années précédant l'année de la fin présumée de l'E.R.P.).* Haut commissariat de la république française en Allemagne, Direction générale des affaires économiques et financières, 1 January—1 July 1950, 7 vols., 599 pp., numerous tables and diagrams.

1. Population. 2. Agriculture. 3. Machine-tools. 4. Coal, coke and gas. 5. Electricity, engine fuels, secondary sources of energy. 6. Balance-sheet of energy. 7. Iron, pig-iron, steel, aluminium, copper.

241 PILLIET, George (with the assistance of JAMIER, L.-P., AUCLAIR, P., PILLIET, Y. and of the Centre de jeunes patrons). *Inventaire économique de la France* (The French Year Book), 4th edition, Paris, "Les ordres de Chevalerie", 1950.

This excellent overall report gives accurate, detailed information on every aspect of the French economy and most illuminating general views. A prominent place is given to the study of various, energy problems. Carefully compiled statistics show the level reached in each branch of production and extremely valuable information is supplied on work in progress and future prospects for the utilization of various forms of power, from the classic forms to geothermal energy, sea and tidal energy and atomic energy, which are still at the planning and experimental stage. This compact and informative report provides one of the best sources or a detailed study of the energy problem in France and also contains a wealth of information on such areas as North Africa, the Saar and Western Germany.

242 QUIGLEY, Hugh. *Power Resources of the World.* World Power Conference, 1929.

A study on an international scale of existing knowledge of coal, oil, gas, water and electric power, with assessments of reserves and production. A selected bibliography for 1924-28 is included.

243 SORRE, Max. *Les fondements de la géographie humaine.* Volume II. "Les fondements techniques." Part. I. "Les techniques de la vie sociale. Les tech-

niques et la géographie de l'énergie. La conquête de l'espace." Paris, Armand Colin, 1948, 608 pp., 35 maps and figures.

Only the second part of this work (pp. 209-392) deals with energy problems. The fundamentals of the geography of energy may be considered from three different points of view: harnessing, utilization and transport. In dealing with them, this study discusses the relevant problems from both the historical and the geographical standpoint. Human engines; history and present problems. The distribution of natural sources of energy and the history of their harnessing by man; the first forms of utilization (fire, water and wind); technical progress and the present geography of energy. Many bibliographical references.

244 TAIX, G. *L'énergie et son utilisation.* Paris, Imprimerie Nationale, 1949, 17 pp.

The text of a lecture given at the Sorbonne on 21 June 1949. An account of the tremendous production of energy in the United States of America (the equivalent of 1,100 million tons of coal), and of the savings that a rational use of energy could effect; by this means, the yield of energy in France could be increased 15 to 18 per cent (or by 15 to 18 million tons of coal). Present plans for equipment are inadequate and, if provision is not made for further equipment, France's energy position is bound to deteriorate.

245 VINCENT, Maxime. *Réflexion sur l'utilisation future des énergies naturelles.* Paris, Fischbacher, 1924, 80 pp.

A study of the numerous mechanical and thermal sources which could be used: barometric veriations, winds, waves, direct solar heat, variations of temperature of seas and lakes, heat of the globe marine currents, etc.

246 VOWLES, H. P. & M. W. *The Quest for Power* London, Chapman & Hall, Ltd., 1931.

A fascinating study of the quest for power from prehistoric times to the present day. In few books is the early history of the subject so fully treated.

COLLECTIVE OR ANONYMOUS PUBLICATIONS

247 *Bilan de l'énergie en France, en Grande-Bretagne et aux Etats-Unis de 1929 à 1944,* published by the Institut de conjoncture, Special Study No. 5, Service national des statistiques, 172 rue de l'Université. Paris 1946, 75 pp., numerous graphs.

A balance-sheet of the various sources of energy (coal, electricity, illuminating-gas, oil and its by-products, substitue fuels, natural gases) and of their consumption in the different countries in question. A comparison of these various balance-sheets, as well as of the output, use and productive capacity of these sources of energy in those countries. Future prospects. At the conclusion of the study there is a balance-sheet of the energy in France in 1945, with numerous tables indicating the consumption (production, transport, industries, domestic uses, etc.).

248 COMISSION SPÉCIALISÉE DE L'UNION DES INGÉNIEURS ET DES TECHNICIENS FRANÇAIS. *L'énergie.* Cahiers unitec, No. 2 (special issue), September 1947, 28 pp.

Study, for each of the main sources of energy (solid and liquid fuels, natural gas, electric energy, coal gas), of production in 1947, of demand, and of possibilities in the way of improvements and savings. Numerous statistical tables.

249 "Development of Man's Use of Power." *Nature,* 1950, v.-166, No. 4224, p. 636.

Discussion by Section H (Archaeology and Anthropology) on the subject of "Man's Use of Power", studied by the Birmingham Congress of the British Association for the Advancement of Science (1950). The main papers were those of B. A. L. Cranstone (British Museum) on "Primitive Man's Use of Power", A. Stowers (Science Museum, London) on "Some Primitive Applications of Power for Pumping and Blowing", and G. E. Fussell on "Agricultural Change and the English Villages". Criticisms and suggestions were made in particular by Professor H. F. Humphreys, Mr. Digby, Sir Harold Hartley (President of the British Association) and Dr. R. N. Salaman (Chairman of Section H). The reports and discussions cover the whole history of mankind, starting with the paleolithic and neolithic ages, going on to deal with Greek and Roman times, the Middle Ages, and the seventeenth, eighteenth and nineteenth centuries, and ending with the period following the second world war.

250 *Kent's Mechanical Engineers' Handbook.* "Power" (Twelfth Edition). New York, John Wiley & Sons, Inc.

The best-known American mechanical-engineering pocket book is now divided into two large volumes, the second being entitled "Design and Production". The "Power" volume gives detailed technical data on all forms of power, including compressed air, water power, steam plant, internal-combustion engines, gas turbines, atomic energy, transport, refrigeration, heating and ventilating and electric power. (See also *Electrical Engineers' Handbook.*)

251 *Notes et études documentaires.* "Extraits de l'Inventaire des ressources de l'économie française en 1949. I. Bilan de l'énergie." *La documentation française,* No. 1,354, 1950, 22 pp.
This work traces developments in 1949 with regard to coal (national production, imports and deliveries from the Saar, consumption and position of the coal industry); electric power (national production and consumption); and lastly, oil products (importation of crude oil, production and utilization of natural gas from South West France, refineries, import and export of finished products, consumption).

PUBLIC LECTURES

Given at the Midland Institute in Birmingham at the time of the British Association Meeting
Nos. 252-255

252 No. 1. August 22nd. "Birmingham and the Industrial Revolution." W. V. C. Gale, F.R.Hist.S.

Introduction; early forms of steam power among the ancients; industry before mechanical power; Savery's engine; Newcomen's engine 1712 in the Midlands; description of it; their significance; growth of local coal and iron trades a result; Boulton and Watt partnership in Birmingham; further improvement by Watt; totative motion; Trevithick at Bridgenorth; expansion of industry; technicalities of iron trade; new machinery and methods; recession in iron trade; reason; new trades come to the district; the present situation.

253 No. 2. August 23rd. "Power, Its Production and Distribution." James A. BEARD, C.B.E.

Outlines the theme, later developed by Sir Alfred Egerton, that man's progressive discoveries of the

means of using power "are the history of the material aspects of our civilizations". Productive capacity, and therefore wealth and standard of living of individuals are closely related to the amount of power available per worker. Review of main sources of power. Electricity, produced from mechanical power and immediately reconverted into mechanical power in the form of light, heat, or chemical energy, is important because of the ease with which it can be distributed, applied and controlled. The history of the development of electricity, first as lighting, then as power. An example given is the development of the power supply system on Tyneside (the first public power supply system). The gradually increasing public control and the formation of "The Grid" are described. The development is traced right up to the nationalization of the industry and the post-war programme of the British Electricity Authority, including its plan for a "Super-Grid". The geographical distribution of generating stations is illustrated and the biggest of the four stations commissioned since the war, at Cliff Quay, Ipswich, is described. The problems of coal and water supply to stations and the problems of siting are discussed. A note is included on water-power resources in Wales and Scotland and plans for hydro-plants.

254 No. 4. August 25th. "Gaseous Fuels and their Significance for the Future." Professor F. H. GARNER, O.B.E.

The gaseous fuels and their use in the United Kingdom. About half the coal used in U.K. and the fuels derived from it are used for space heating and cooking. The efficiency of use is only 20 per cent as compared with as much as 60 per cent in the U.S. and 50 per cent on the continent of Europe, although British living space is not heated to such high temperatures. Gas is more efficiently utilized for heating than is electricity. Gasification of coal would enable it to be used more efficiently in industrial and domestic heating and in manufacturing operations. Experiments in underground gasification of coal are going on. The gas produced might well be used in the gas turbine. The use of cheaper fuels in the larger size gas turbines for the generating of power presents one of the most important problems at present. There are engineering problems to be solved for large gas turbines, but in medium power units (railway locomotives and marine engines) there is an important field, and the gas turbine may compete with the steam turbine in the generation of electrical power.

255 No. 5. September 5th. "Civilization and the Use of Energy." Professor Sir Alfred EGERTON, F.R.S.

A detailed historical survey of the material development of civilization from prehistoric times—"It may be that fire . . . was the chief instrument of man's superiority over the animals"—and showing at each stage how advances in the use of energy advanced the civilizing process. Food and fodder, supplying energy to man and beast have been the main source of energy from the earliest historical times to the present day. Energy derived from wind and water was small in proportion to the energy supplied by animate power. But after the Renaissance two new factors affected the advance of civilization: the development of science and the utilization of stored resources of energy. Then follows an analysis of the present distribution of energy resources and their uses; and of the chief problem now, which is "to increase efficiency of food production per worker for home consumption; energy can help in this", and to deal with surpluses so that they help to counteract deficiencies in other parts of the world. Man's interdependence is stressed throughout. This interdependence has had its effect "on the social structure of the family, the tribe and the nation, and now upon the movement towards a world society. That may be made possible by the invention of electronic computation which is the most advanced stage yet reached in the series of inventions which have brought about "man's interdependence. These inventions are the means by which man's brain seeks to supplement its power from the environment which it creates". Man, defeated by his own contrivance, may be led to the dead-end of non-adaptability; but the story of energy and civilization shows that his individuality and creative power have been a remarkable force in the history of civilization.

256 "The British Fuel and Power Industries." London, *Political and Economic Planning, 1947.*

An authoritative account of the material resources of fuel and power and their utilization.

JOURNALS

257 *Bibliographie d'études et d'articles sélectionnés*, published by the Bibliothèque de la Chambre de commerce de Paris.

This bibliography is the result of a methodical monthly analysis, by specialized personnel, of French and foreign journals, bulletins, reviews or periodicals regularly received by the Bibliothèque de la Chambre de commerce de Paris. The table of contents includes an important section devoted to the various forms of driving-power and sources of energy (general studies, town gas, electricity, atomic energy, other sources of energy, etc.). The documents mentioned may be consulted at 16 rue Chateaubriand, Paris.

258 *La Conjoncture économique et financière*, bimonthly review, 17 avenue de la Bourdonnais, Paris.

This review regularly gives graphs of power production and resources in France and other parts of the world. The graphs given in August-September 1950 (No. 4, 22nd year) show the evolution of power reserves in France as regards the principal known stocks of the mines, main public services, refineries and depots for the distribution of oil, and hydraulic reservoirs; and we are thus able to compare them with the actual level of power consumption.

259 *Revue française de l'énergie* (charbon, pétrole, électricité, gaz). Librairie sociale et économique, 3, rue Soufflot, Paris. Monthly review published since September 1949.

The *Revue française de l'énergie* deliberately leaves aside the purely technical aspects of power problems and devotes itself to a detailed study of their economic and structural aspects (competition between the different sources of energy, relations between the various firms and the public authorities, etc.). It is mainly concerned with the French aspect of the question, but a large place is given to the examination of achievements in other countries, for purposes of comparison.

II. *Solid Fuels: Coal, Peat, etc.*

260 BARIL. "Importance et avenir de l'industrie du gaz." *Revue française de l'énergie,* No. 11, July 1950, pp. 343-47, and No. 12, August-September 1950, p. 380.

A general survey of the gas industry throughout the world, and more particularly in Western Europe, the United States of America and France. Tables. Average consumption per consumer or per inhabitant for each country. Whereas the percentage of electrification in France is at present over 95, that for gas is only 51, which is very much lower than in other Western European countries.

261 BONE, W. A. & HIMUS, G. W. *Coal, its Constitution and Uses.* London-New York, Longmans, Green & Co., 1936.

A treatise on the economic, geological, chemical and technological aspects of coal, not only in Britain but in the whole world. It includes large sections on coal utilization in the major coal-using industries and a section by R. J. Sargent on fuel economy in industrial furnaces.

262 CHARDONNET, Jean. *Le charbon. Sa production, son rôle économique et social.* Grenoble, Arthaud, 1949, 210 pp., 24 figs. and maps, 13 statistical tables. summary bibliography.

Coal no longer holds a monopoly as a source of energy as it did in the nineteenth century, but it still takes, and will no doubt long continue to take. first place in this field. Thus it plays an essential part in world economy and raises numerous different problems, which may be considered from the dual angle of production, properly so called, and of its consequences. Hence the plan of the work, which is divided into two parts: 1. World coal production and its conditions. 2. The consequences of this production and the main problems it raises. Apart from the problems of the use of coal in industry and trade, the second part deals in detail with the social and demographic aspects of coal extraction, with particular emphasis on the numerous ties which bind the production of coal to the population's manpower and its occupational and social distribution. The whole provides a complete study of the part played by coal in modern life.

263 CORVAL, G. de. "Les tendances de la consommation charbonnière en France." *Revue française de l'énergie,* No. 12, August-September 1950, pp. 360-8. and No. 14, November 1950, pp. 46-9, tables and diagrams.

It is interesting, at the conclusion of the period of coal-shortage in Europe, to study trends in coal consumption and to compare them with production trends. Consumption trends depend in part on the structures, which determine the greater or lesser sensitiveness of demand to economic fluctuations, and in part on the development of consumption itself. The study is divided into three crowded chapters: I. The structure of consumption (iron and steel and other industries, public services, railways, domestic uses) and the stability of demand. II. The development of consumption and the problem of specific consumption (evolution since 1929). Competition from other sources of energy. III. Forecasts of consumption.

264 ELLISSEN, Robert. *Le gaz dans la vie moderne.* Series "Les questions du temps présent." Paris, Librairie Félix Alcan (stock taken over by the Presses universitaires de France).

This work, published in 1933, is an intelligent summary of the history of coal-gas production and of its uses in modern life. It may be consulted with advantage in conjunction with the more recent work by Jacques Le Clézio, published in 1947 in the series "Que sais-je?" The conclusions of the two works differ. In 1933, competition from electricity was less intense, not to speak of atomic energy which at that time was of merely theoretical importance, although serious consideration was already being given to ways of putting it to use. Furthermore, Mr. Ellissen writes from a more technical standpoint than Mr. Le Clézio, who refers more explicitly to the social and economic changes resulting from the industrial and domestic use of gas.

265 FERRONIÈRE, Y.; DUBOIS, G.; BOISSELET, L.; WEILL, H. & ALLAIS, A. *Les Tourbières françaises.* Ministère de l'industrie et du commerce, Direction des mines, Paris, Imprimerie Nationale, 1949. Part I: Memoranda, 227 pp., figs., maps. Part II: Prospecting Results, 634 pp., maps, plans.

The first part of these documents is a catalogue of French peat resources, drawn up during the war. The history, geology and chemistry of peat. Legal administration of peat-beds. An economic study by A. Allais reviews questions connected with French production, imports, prices and the utilization of peat. Bibliography of 546 titles.

GALE, W. V. C. See No. 252.

GARNER, F. H. See No. 254.

266 HADDOCK, M. H. *Cultural Contacts of Mining.* London, Routledge & Kegan Paul, 1949.

A book on the social aspects of coal mining written primarily for young men choosing a career.

267 LE CLÉZIO, Jacques. *L'industrie du Gaz.* Series "Que sais-je?", No. 239. Paris, Presses universitaires de France, 1947.

The first chapter of Mr. Le Clézio's work is almost an excursion into mythology, as the author describes the reactions of primitive peoples to emanations of natural gas; he also mentions, however, the intelligent use made of such sources by the followers of Confucius about A.D. 900 as well as by the ancient Greeks and Romans.

The gas industry and the use of gas for lighting

and heating really date from the eighteenth century and are traceable more particularly to tests made by Frenchman Philippe Lebon, the Englishman William Murdoch and the half-Czech half-Englishman Winsor, whose real name was Winzler. The latter may be regarded as the true pioneer of gas lighting for cities, which he succeeded in establishing despite violent and understandable opposition from commercial and even from very diverse scientific quarters.

The author considers the technique of gas manufacture, transport, distribution, the uses of gas in modern life and, lastly, the administrative and economic structure of the gas industry. His last chapter headed "The Future of Gas" is obviously the most suitable starting point for a thorough critical discussion. There are two aspects to the problem of the future of gas. In the first place, in countries and areas that are now under-privileged and backward as regards material civilization, gas may still be a factor in modernizing living conditions. In this connexion, the information supplied by the author on present and planned developments of the gas industry in the U.S.S.R. are highly significant. France, which does not lead the world in matters of domestic comfort, is another favourable ground for the development of this industry and of its commercial ramifications. more particularly in country areas. But in urban centres and countries with an advanced material civilization, we may anticipate increasingly strong competition from electric power, not to speak of what the author refers to, somewhat cryptically, as "a new form of energy with which people are concerned far more for strategic than for domestic purposes" and which cannot fail to "revolutionize the technique of heating" (page 134). Indeed, among the sources of energy now used industrially, we are bound to consider the question of atomic energy and its use for peaceful purposes.

268 LYLE, Oliver. *The Efficient Use of Steam.* London, His Majesty's Sationery Office, 1947.

This book was written for the Ministry of Fuel and Power to assist the work of the Fuel Efficiency Committees. It is an exhaustive treatise on the use of steam for power production and process heating, written from the standpoint of eliminating sources of waste and of securing the most efficient combination of plant.

269 MASON, E. *Practical Coal Mining for Miners* (2 vols.). London, Virtue & Co., Ltd., 1950.

The approach is simple and practical but thorough and comprehensive. The illustrations are outstandingly effective. The first volume covers the story of coal, shaft sinking, methods of mining, ventilation, lighting and safety. The second volume is concerned with the engineering services, coal preparation, management, organization, planning and surveying.

270 MOORE, E. L. *Coal: Its Properties, Analysis and Classification, Geology, Extraction, Uses and Distribution.* New York, John Wiley & Sons Inc., 1947.

The scope of this book is fully defined by its title.

271 RANDET, M. P. "Le bois de feu dans l'économie générale." *Revue des eaux et forêts,* August 1944, No. 8, pp. 433-57.

This article was called forth by economic conditions and the substitution of firewood for fuel oil, petrol or coal. History of firewood until the middle of the nineteenth century. For thousands of years firewood was almost the only source of energy; coal was only discovered in the twelfth century; it came into everyday use in England only in the fifteenth century and in France after the discovery of the Anzin mines (1734). Present production of firewood in France. Its possible use for heating (domestic or industrial; bakeries) or for carburetting (motor-fuel wood, charcoal, liquid fuels extracted by hydrolysis or pyrolysis of wood). Comparison between these two types of uses. Wood, in normal economic conditions, can be used as motor-fuel only on a strictly regional basis; the growing post-war use of wood for heating, on the other hand, should appreciably reduce imports of energy, though this is dependent on the systematic modernization of heating appliances.

272 REUFFLET, Paul. "Les grands gisements de lignite exploitables à ciel ouvert et le problème de l'énergie. Une réalisation française: Hostens." *Annales des Mines.* 1949, V., pp. 25-41, 10 figs.

Study of lignites and of the world situation with regard to their deposits and prospection The extraction of lignites may be worth while, particularly for new countries in process of equipping themselves with energy, where open-cast mining can be used and the soil has little value. Study of the Hostens equipment, whose almost only use is to provide thermal energy for the Hostens power-house. The winning of low-grade fuels, especially of lignites, would seem to offer advantages provided there are large reserves and that extraction costs are low. For example, a kwh of lignite under Hostens conditions costs 2.73 francs, which is even less than the amortization costs of a hydraulic installation, to which must be added operating and maintenance charges. Moreover, this type of operation is not subject to the whims of rainfall, and, since it calls for only limited and high-grade labour, has a better chance of remaining unaffected by social disturbances. The study ends with a note on the extraction of lignite in Australia, comparing the achievements of France with those of a new country possessing very considerable deposits.

273 ROBERT, G. "L'industrie gazière de la Grande-Bretagne." *Revue française de l'énergie,* No. 9, May 1950, pp. 261-7, No. 10, June 1950, pp. 294-8, 1 map.

The customs and mode of thought of the inhabitants of a country are not irrelevant to an assessment of the activity of an industry like gas, which has a direct bearing on living conditions, and which is extraordinarily prosperous and vigorous in Great Britain. The first gas company was founded in 1810, and by 1946 there were over 1,000 undertakings distributing gas to 85 per cent of the population (in France, the figure is 53 per cent and the annual consumption is much lower). History and structure of the British gas industry. Consumption. Nationalization and its effects.

274. ROMEUF, Jean. *Le charbon.* "Que sais-je?", séries No. 193. Paris, Presses universitaires de France, 1949, 128 pp. fig.

The author deals first with the different uses of coal as a source of energy and as a raw material. Any decrease of its consumption in industry causes parallel decreases in numerous branches of production, owing to its vast area of repercussion. The next two chapters give data on coal formation, prospecting methods, boring, mining installations, the latest techniques of extraction, and the treatment to which coal is subjected at the pit-head before being delivered to users. The concluding part of the work is a very comprehensive survey on the world's coal reserves, the lack of balance between production and the various nations' needs, the different aspects of mining legislation and the complexion, in France, of these various problems. Compared with other sources of energy the coal-mining industry will, for a long time yet, be a prime factor in the world's power resources.

275 SCHNEIDER, Eugène. *Le charbon, son histoire, son destin.* Paris, Plon, 1945, 351 pp.

After outlining the history of coal in ancient times and in the Middle Ages and studying early French coal-extracting, the author shows how the great coal industry came to life, mentions some of its pioneers, and emphasizes the part played by the capital held by the aristocracy and bourgeoisie. Speaking of modern times, he describes the work of the mining engineer and the miner. (One chapter is devoted to the latter's character and life). The work ends with an examination of present theories on the formation of coal, followed by a treatise on the trends of this key industry and its derivatives.

276 SMITH, N. *Gas Manufacture and Utilization.* British Gas Council, 1945.

An elementary account of the manufacture, purification and utilization of gas.

277 WEIL, H. & LANE, J. C. *The Technology of the Fischer-Tropsch Process.* London, Constable & Co., Ltd., 1949.

Large-scale production of synthetic petroleum with a coal base has been made possible by the Fischer-Propsch process. The authors study the process from the technical viewpoint and also analyse its economic repercussions. Information on the latest developments will be found in the reports on this subject by the U.S. Bureau of Mines.

278 ZWEIG, F. *Men in the Pits.* London, Victor Gollancz, 1947.

A study of miners and their habits.

COLLECTIVE OR ANONYMOUS PUBLICATIONS

279 AMERICAN MINING CONGRESS. *Coal Mine Modernization Yearbook.* Washington, D.C.

This yearbook contains, in addition to the proceedings of the Annual Coal Convention, articles on every aspect of mechanical mining.

280 COMMISSION ÉCONOMIQUE POUR L'EUROPE. "La situation de l'Europe à l'égard du charbon entre 1945 and 1949 comparée à celle de 1937", par le Sous-comité de la répartition, Comité du charbon. *Annales des Mines,* 1949, V. pp. 25-41. Tables

A study of the movement of production, imports, exports and consumption of solid fuels in Europe since 1937 Serious situation of the coal industry in 1945. Production and exportable supplies from 1946 to 1948. Extra-European supplies during the same period. Data regarding the number of underground workers on the registers in the different countries, production per man and per category of work.

INTERNATIONAL LABOUR ORGANIZATION
Coal Mines Committee. ILO, Geneva
[Nos. 281-283.]

281 *Record of the First Session,* Geneva, 1947, 186 pages.

The first session was held in London in 1945. Composition and powers of the Committee. A general picture of the coal-mining industry throughout the world, its social conditions and working techniques. Its recent reorganization in Great Britain and in France. Two reports are attached to the record.

Report I, 88 pages. Social conditions in the coal-mining industry. World events in this industry in 1946. Nationalization of the mines in the United Kingdom and in France. Miners' strikes in the U.S.A. An annex contains a plan for a survey of the resources of the coal-mining industry considered from the economic, social and technical points of view.

Report II, 159 pages. This report deals with the use of the resources of the coal-mining industry. It includes a study of the economic position of this industry in Western, Central and Eastern Europe, North America, Asia, Oceania and Africa; a study of social policy in this industry in 1946; and a study of man-power problems.

282 *Record of the Second Session,* Geneva, 1948, 212 pages.

The second session was held at Geneva in 1947. In addition to the record proper, this document contains a series of resolutions and projects concerning labour conditions in the coal-mining industry.

283 *Record of the Third Session,* Geneva 1949.

I. *General Report,* 211 pages. This report contains numerous tables and a folding coloured map of the coal-mining industry in Germany.
Follow-up of the work of the second session. Study on miners' pensions. Balance sheet and prospects of the coal-mining industry throughout the world in 1946-47. The coal-mining industry in Germany.

Report II, 40 pages. The protection of young workers employed underground in coal mines.

Report III, 103 pages. The vocational retraining of disabled miners.

Report IV, 58 pages. Hours of work in coal mines.

284 *Report on the Gas Industry in Great Britain.* London, Political and Economic Planning, 1939.

A statistical survey of the gas industry before nationalization, including current trends and problems.

285 UNITED NATIONS ORGANIZATION. "Coal Production and Trade in Europe since the War." *Economic Bulletin for Europe* (UN), 3rd Quarter, 1949, pp. 15-26.

The period of acute shortage in Europe ended in 1949, but the European coal market still exhibits features very different from that of pre-war days. The production and consumption of coal have remained very much below the pre-war figures, although the exceptional imports from the United States of America have been considerably reduced. Coal has apparently sometimes been replaced by other fuels in the importing countries. Generally speaking, consumption has fallen greatly in relation to production.

286 *Waste-Heat Recovery from Industrial Furnaces.* London, Chapman & Hall, Ltd., 1948.

A treatise based upon a series of papers presented to the Institute of Fuel.

III. *Liquid Fuels: Petroleum, etc.*

287 AGOUT, Marthe. *Bibliographie des livres, thèses et conférences relatifs à l'industrie du pétrole.* Paris, Impr. de J. et R. Sennac, 1949, 325 pp., pl.

This is a very valuable bibliography of 6,408 titles of works and French and foreign studies published from 1847 to 1947 on oil and the oil industry.

288 BIHEL, André. *Les problèmes économiques du pétrole et l'état.* Thesis. Faculté de droit, Paris, 1938, 299 pp., tables.

Analysis of State intervention in oil matters; mechanization policy, prospecting of the national territory, acquisition of foreign oil sources, development of a national refining industry, development of substitute fuels (bituminous shale, hydrogenation of coal and lignite, fuel alcohol, etc.).

289 BOULARD, F. de. "Les tendances de l'industrie du pétrole aux Etats-Unis." Lecture given at the Centre de documentation chimique, Maison de la chimie, Paris, 1942.

Study of the main activities of the American oil industry; reference to local booms and the growth of "mushroom towns" as the result of the sudden exploitation of oil fields. In conclusion, the author dwells on the manpower question in the United States of America, where the overriding factor is the equal consideration given to intellectual and to manual work.

290 CARBONARO. "L'Utilisation de l'alcool carburant dans les moteurs à explosion." Lecture given at the Centre de documentation chimique, Maison de la chimie, Paris.

Paper demonstrating that alcohol is a first-class fuel, superior in many respects to petrol, provided that it is used in specially designed engines; hence the need for co-ordinated plans for fuel alcohol and for alcohol engines, which, by direct injection, are bound to revolutionize the internal combustion engine.

291 CHARDONNET, Jean. "La course aux pétroles." Paris, Editions du chêne, 1945, *Questions d'aujourd'hui*, No. 19, 32 pp., 2 maps.

The object of this "popular" pamphlet is to give the public some precise details concerning the importance of oil in world economy, particularly in a wartime economy.

292 DALEMONT, Etienne. *Le pétrole.* Series "Que sais-je?", No. 158. Paris, Presses universitaires de France, 1950.

In its abbreviated form, this work contains all the essential facts on the place of oil in modern civilization. In the first chapter, the author considers all the uses of oil, from the internal combustion engine to the protection of orchards in the south of France. Chapter II deals with the techniques used in the oil industry, while Chapter III goes on to consider "the world's oil industry and trade". The production and consumption of oil by area, etc., are analysed so as to indicate export and import trends. In his special study of the position in the United States of America, the author observes that large exporting countries such as the U.S.A. have become importing countries by reason of a sharp rise in consumption and of the increased output in Venezuela. Accordingly, the European countries, with their high consumption and their extremely low production, are gradually turning away from America and covering their needs by imports from the Middle East.

There is a special chapter on the French oil industry which, as is to be expected, is primarily a processing industry. From the economic standpoint, the author objects to any protective measure that might lead to the substitution of such other fuels as alcohol for oil. He also demonstrates that the manufacture of substitutes, or synthetic oils, would be so costly that no protectionist policy could be entertained. In this connexion, he refers to the example of the United States, where little headway has been made with the manufacture of substitutes, even though conditions would be infinitely more favourable than in France.

"Has the earth a sufficient store of oil to meet the world's growing needs?" This is the question with which the author opens his last chapter on the future of oil (page 125). His reply is decidedly optimistic, an optimism justified by daily improvements in prospecting, boring and extraction methods and by the ever wider — and still not fully realized — extent of oil fields. Lastly, progress made in refining methods is also largely instrumental in the establishment of reserves.

In the introduction to his work, the author objects to the *"facile romanticism"* by which oil problems have always been surrounded. Towards the end, he resolutely dismisses all prospects of a too distant and problematic future in which oil production and consumption would be secondary to other forms of industrial civilization. All things considered, the author feels that there are at present no scientific or economic grounds for fearing that oil will be superseded by atomic or any other form of energy.

293 DELAIS, F. *Le pétrole au point de vue économique. La politique de la production.* Paris, Payot, 1921, 158 pp.

An historical essay on the part played by oil in world diplomatic, financial and political events.

294 DIOR, Raymond A. *Le pétrole et la guerre.* Special number of *Crapouillot*, July 1939, 68 pp., figs., portraits, maps.

A study of the role played by the oil trusts in the world war of 1914-1918 and in the economic, diplomatic and political life of the post-war period. The whole history of the last 30 years shows that, in peacetime as in wartime, the problem of oil in France is dominated by foreign trusts. The Axis cannot make war without American oil (United States, Mexico, Venezuela); but German and French engines consume petrol from the same source. The dominating

role played in world affairs by the international banks and the great trusts is a strange and very dangerous feature of the capitalist system.

295 ERMAKOFF, Michel R. "Les carburants cétoniques". Lecture given at the Centre de documentation chimique, Maison de la chimie, Paris.

Description of ketone fuels (the main characteristic of which is their very high anti-knock capacity) and of industrial methods for the manufacture of these fuels by synthesis and fermentation. Concludes with economic considerations on the possibilities of setting up a large ketone fuel industry in France.

296 FONTAINE, Pierre. *La guerre occulte du pétrole.* Collection "Hommes et continents". Paris, Dervy, 1949, 223 pp.

This essay is designed to explain to the general public that the present world oil situation and the main international events reflect the "race" for oil, which completely dominates the economic life of all great countries.

297 FORTIER, Fortunat. "Deux controverses touchant le commerce des pétroles." *Acta Economica,* April-June 1950, pp. 111-42.

Aspects of Anglo-American rivalry with regard to petroleum.

298 FRANKEL, P. H. *L'économie pétrolière, structure d'une industrie.* Introduction and appendix by Etienne Dalemont. Paris, Librairie de Médicis, 1948, 259 pp. (French edition of *Essentials of Petroleum, a Key to Oil Economics.*)

A study of the graph showing the demand for and supply of oil products, and the price mechanism. The structure of the oil industry reflects the pressure of specific technical and economic facts, but also the activities of men—individuals or groups—who interpret those facts in the light of their own interests and control the complicated play of "natural" factors. The oil industry is not one of those which automatically find their own equilibrium; it is influenced by the political and social environment, and particularly by the wishes of the head of the enterprise. The author, who is himself an oil man, brings to his strict economic analysis a first-hand knowledge of a very special environment and profession. The French edition also contains a study by E. Dalemont entitled: "L'industrie française du pétrole, données particulières et caractères propres".

299 JOUAN, R. *Le pétrole, roi du monde.* Paris, Payot, 1949, 196 pp., 6 graphs.

The first and second world wars showed the decisive importance of oil in modern life and in military operations. When peace was re-established, oil invaded all fields of national and domestic activities, not only as a source of energy but as a component of all kinds of products (explosives, rubber goods, soaps, plastics, nylon, etc.). Oil has an even more direct influence on the life of man for, as it is the very foundation of the power of states, it has become for states a matter of the very first concern, and has already been the subject of tremendous struggle and the keenest competition. Oil reigns supreme, but its position is undergoing rapid changes as between the "coal age" which is drawing to a close and the "atomic age" which is not yet established. Any attempt to give a picture of the present situation can therefore only bear on one stage in a rapid process of evolution.

After an historical account of oil and a brief outline of the industries based on it (prospecting, extraction, refining, storing and transport), a chapter entitled "The Secret War for Oil" recounts the history of the famous Standard Oil Company, of its founder John Davidson Rockefeller, and of the international rivalry on the oil market in the nineteenth and twentieth centuries. This rivalry led, at the end of the second world war, to the victory of the Anglo-Dutch, who hold the same percentage of world reserves as the Americans (39.9 per cent as against 40.1 per cent), the latter having immense reserves on their own territory. At present, the world oil industry is geographically divided between North America (284,315,000 tons in 1948), South America (84,000,000 tons), Asia (62,000,000 tons), Europe including Russia in Asia (35,000,000 tons), and Africa, which is still almost wholly unexplored (1,900,000 tons). The United States of America consumed 230,000,000 tons in 1946 and Europe 35,800,000. It is anticipated that oil consumption in Europe in 1952-53 will be double what it was in 1935-38. In Great Britain, France and Italy there should be a vast extension of the refining industry whose capacity in the case of each of these countries should, on the expiry of Marshall aid, reach 50,000,000 tons. At the end of 1948, the French refining industry had a productive capacity 43 per cent higher than that of 1939. Pipe-lines are being planned; the extraction of natural petroleum is being developed; and, in December 1948, 3,157 tons of synthetic petrol were produced. The recovery of the petroleum industry in France is most encouraging.

300 LE FEVRE, Georges. *Sa Majesté le pétrole.* Paris, Hachette, 1950, 254 pp.

In the form of travel notes, reflexions and recollections interspersed with a few statistics and historical and geographical data, this work endeavours to describe the human aspect of the petroleum industry (working conditions, teams of borers, the power of oil and the life, aspect and atmosphere of the oil towns in Texas, Venezuela, Iran and Arabia), and raises the question of the standard of life. The natives seem to derive no advantage from these great industrial centres, and their standard of life is no better than before .

301 LESOURD, Olivier. *Annuaire-guide du pétrole et du chauffage au mazout, industrie, commerce, fournisseurs.* Preface by Mr. Louis Pineau, Paris, printed by the author, 1949, 526-96-32 pp. Tables.

This year-book is mainly designed for technicians and business people. The most important section deals with the latest regulations in France and the rest of the world (administrative organization, professional organization, universal oil policy, customs regulations, allocation, distribution, etc.). The section dealing with consumption occupies four pages.

302 PASSAGEZ, Albert. *L'Azote et le pétrole.* Paris, Librairie Octave Doin, 1924.

The vital economic and military importance of nitrogen and petroleum. The author, writing from the Belgian standpoint, advocates the Georges Claude process for nitrates (synthetic preparation of ammonia by direct union of hydrogen and nitrogen). With regard to oil, he considers it a matter of urgency for Belgium to use suitable substitutes and to survey the oil fields in its possession in every part of the world.

303 PASTRE, Henri. *Le Problème du carburant en France et dans ses colonies.* Paris, Presses universitaires de France, 1925.

This work sets out to demonstrate, by citing a par-

ticular case, the influence that a certain national and social situation may exert on scientific research and its practical applications. Towards 1925, France feared a fuel shortage. The author refers to the discussions and clashes of interests that arose out of proposals to use alcohol as a fuel.

304 PELLISSIER, Jacques. "La recherche du pétrole en France et dans l'Union Française." *Revue française de l'énergie*, No. 13, October 1950, pp. 11-20, 2 maps, and No. 14, November 1950, pp. 49-61, 5 maps.

History of the search for oil, which did not begin in France until 1937, when the "Centre de recherches du pétrole du midi" was set up. A detailed study of the prospecting carried out in France and in the French Overseas Territories (Morocco, Algeria, Tunisia, the Gaboon, the Cameroons, Madagascar). Questions of finance and future possibilities.

305 PRATT, W. E., & GOOD, Dorothy (Eds.). *World Geography of Petroleum*. Princeton, Princeton University Press, 1950, 464 pp.

This book, which is Special Publication No. 31 of the American Geographical Society, is a comprehensive discussion of the world oil situation. Chapters are contributed by 20 experts, petroleum geologists, administrators and government agency officials, who describe in detail the world's important oilbearing regions. The four main divisions of the volume are entitled: Petroleum in the Ground; The Functional Organization of the Petroleum Industry; The World's Petroleum Regions; Aspects of Utilization. The purpose of the work is expressed in the Preface as follows: "In the present survey geography describes the world's petroleum-producing regions on a comparative basis and, in a world-wide view, synthesizes the broad problems of petroleum supply and utilization". There is an extensive Appendix, including a very complete bibliography. A highly useful feature of the book is the large number of maps, photographs and tables supplementing the text.

306 RISLER, A. "Le pétrole dans l'économie française." *Annales d'économie politique*, April-June 1949, pp. 47-57.

Oil as a source of energy throughout the world: production, refining, transport. Oil in France: refining, transport, distribution. Future prospects.

307 RIVES, Jean. *L'autarcie allemande, le pétrole et la guerre. Cahiers d'Information Française*, No. 5. Paris, Jouve, 1939, 69 pp., map.

Europe's fuel requirements in time for war (aviation, mechanized divisions, navies). German oil supplies (imports, production, synthetic fuels, benzols and alcohols, stocks). German oil supplies from Italy, Hungary, Mexico, U.S.S.R., Poland and Japan. Rumanian production and German designs None of the Axis powers has natural oil resources adequate to meet its needs. They have adopted the same programme of national self-sufficiency by the manufacture of synthetic fuels as Germany, but only the latter can meet a third of its needs by this method. For the remainder, Germany has to rely on imports from abroad; by negotiations with certain suppliers such as Rumania and Mexico, she is able to obtain considerable quantities of oil, giving rise to the paradoxical situation in which nations already almost at war exchange arms with one another: the Rumanian oil supplied in exchange for Skoda machine-guns is likely to come back shortly to Bucharest in Hitler's tanks and armoured cars. In spite of the new opportunity of access to Rumanian oil through Czechoslovakia, Germany must solve the oil problem before opening hostilities. If the democracies cease to devote attention to this problem they might find themselves facing a formidably armed Germany, which, after annexing Rumania's oil deposits, would have adequate supplies of fuel, which alone could confer on her war equipment the power of movement and therefore of offensive.

308 SCHMITZ, P. M. E. *Enfance et destins d'un géant: l'épopée du pétrole*. Preface by Mr. Louis Pineau, Director of the "Office national des combustibles liquides." Paris, R. Pichon et Durand-Auziat, 1947, x-277 pp.

Historical sketch of the early days and development of the petroleum industry (1859-1918). Early days up to 1880. The refining industry from 1880 to 1914. This development is considered from the point of view of the technical advances made in the petroleum industry (extraction, refining, transport, distillation, chemistry of petroleum) and of the individual human factor in all these, rather than from the economic and political points of view.

309 TIRASPOLSKY, W. "Un nouveau continent attend les pétroliers." *Techniques et applications du pétrole*, April and May 1946, 16 pp., fig.

The floor of the ocean has not yet been methodically prospected for oil, although, in the coastal oil-fields, drilling has for a long time been encroaching on the land covered by the waters (Long Beach in California, Maracaibo in Venezuela, the coastal swamps of Louisiana and Texas, etc.). So far, however, no one has gone beyond a depth of 40 m.; if it were possible to develop equipment and techniques by which normal boring could be carried out at a depth of 200 m., it would be possible to add to our oil-fields almost all the continental seas and ocean shallows: 8.4 per cent of the oceans, or nearly 6 per cent of the surface of the globe, is above this level. If these areas were reclaimed for this purpose, the economic effect would be incalculable. The first efforts to secure this end have been made by the United States of America, which have just taken in the 1,900 km² of the American continental shelf. Measures to be taken in Europe. The technique of under-water boring. Plans for the future.

310 WARTANOFF, Boris. *Le pétrole russe*. Paris, O. Zeluck (printed in Switzerland), 1948.

General information concerning Russian oil, its main centres (the Caucasus, the Volga-Ural area, Central Asia, Siberia, Sakhalin), its trade (which is completely controlled by Soyuzneft, the Soviet crude petroleum trust) and its new markets. The history of Russian petroleum can be divided into three periods. The first, which extends from 1880 to 1905, marks its origins; it is characterized by the initial rivalry with Standard Oil. The second period extends from 1905 to 1914, and is characterized by a drop in production due to the social troubles and their baneful influence on the whole Russian economy. The third period extends up to 1941. Intensive industrialization, and the unparalleled development of the aircraft and automobile industries called for tremendous efforts in the way of oil exploitation, and these produced extraordinary results. The author of the present study is an Armenian, the son of an "oil man", who lived in Russia up to 1934.

311 ZIEGLER, V. *Le pétrole, son origine, sa composition, sa recherche*. Work adapted from the English by Commandant A. Martin. Paris, Librairie Félix Alcan (stock taken over by the Presses universitaires de France).

This popular scientific work opens with a chapter on

the beginnings of the oil industry in the United States of America and has a concluding chapter on "oil investments", both of which are worth consulting. When it was published, in 1922, there was as yet no question of nationalization, and oil production was organized on a purely capitalistic and liberal basis, with all the advantages as well as the defects of the system. Furthermore, the "romanticism" criticized by the author of the more recent work on Petroleum published in the series "Que sais-je?" was then the fashion, for this was the epoch of the mysterious Lawrence of Arabia. As a matter of fact, this romantic approach is absent from Commandant Martin's adaptation; it concludes with John Hays Hammond's "Ten Commandments for Mining", full of wisdom and common sense; we will only quote the tenth: "Don't lose your head because you have shares in oil instead of in some other industrial concern."

COLLECTIVE OR ANONYMOUS PUBLICATIONS

INTERNATIONAL LABOUR ORGANIZATION
Petroleum Committee. ILO, Geneva
[Nos. 312 to 314]

312 *Record of the First Session*, Geneva, 1948, 192 pages.

The first session was held at Los Angeles, in February 1947. Extracts from the report prepared by the International Labour Office for this first session, and determination of the purposes and functioning of the Committee. A picture of the petroleum industry and its trends. World distribution of petroleum. Importance of the petroleum industry in the various countries. Social problems. Record of proceedings.

313 *Record of the Second Session*, Geneva, 1950, 146 pages.

The record of this session, which was held at Geneva in 1948, deals mainly with social questions. A series of reports is attached to it.

I. *General Report*, 71 pages, with a study of recent events and developments in the petroleum industry (growth of demand; supplies and reserves; world expansion of the industry).

II. 84 pages. Recruitment and training.

III. 120 pages. Safety measures in the petroleum industry.

IV. 48 pages. Industrial relations (trade unions, collective agreements, etc.).

314 *Record of the Third Session.* Geneva, 1950.

I. *General Report*, 75 pages. A detailed economic study of the production and consumption of petroleum in each country. The world market.

Report II. Social conditions in the petroleum industry. The main problems. The social services and their role in countries which are little developed economically, as well as in highly industrialized countries.

315 *Le pétrole dans la vie nationale.* Secrétariat général du gouvernement, Direction de la documentation, Paris, 1948, 31 pp., 12 photographs, 1 diagram ("La documentation française illustrée", No. 22, October 1948).

Oil in France and the French Union. Oil refining and French policy with regard to refining. Transport and storage of oil products. The future of inland transport in France. Total value of the plant possessed by the French oil industry before the war; destruction and present position. By-products of oil, their use and consumption in France.

316 "Le problème de l'alcool carburant en France". *Revue française de l'énergie*, No. 8, April 1950, pp. 228-36 and No. 9, May 1950, pp. 268-75.

The problem of the over-production of alcohol arose when the first beetroot distilleries were established in 1840. At present, efforts are being made to avoid the over-production of alcohol by advocating its use as a fuel. Economic and technical data. The return to a general over-production of alcohol from beet is an economic absurdity, for alcohol is too expensive a product for its use as fuel to be of even limited value. On the other hand, French consumption of sugar (an extremely calorific food) per inhabitant is 50 per cent less than that of the other great nations. The most pressing need is to establish new sugar-refineries and introduce regulations for encouraging the conversion of beet into sugar instead of into alcohol.

317 *The Efficient Use of Fuel.* London, His Majesty's Stationery Office, 1944.

Under the direction of the British Fuel Efficiency Committee this book was written during the war by a number of experts. It deals with all that the practicing engineer would want to know about fuels and their use, without requiring any specialized knowledge of the subject in advance. Processes in which fuels are used are described, with notes on the efficient use of the fuels concerned.

318 UNION DES CHAMBRES SYNDICALES DE L'INDUSTRIE DU PÉTROLE. *L'Industrie française du pétrole*, Neo-publicité, Paris, 1950, 64 pp.

This phamplet is intended to spread a knowledge of French efforts in relation to oil. It examines in turn the problems of prospecting (whose most successful example is the St. Marcet natural gas deposit), imports, tankers and refining (France was the first country to create a maritime industry); distribution, consumption, investment, and the social arrangements and organization of the profession. Well chosen photographs and very clear tables and charts are used in the pamphlet.

IV. *Hydroelectric Energy and Electricity*

319 AILLERET, P. "L'évolution probable de la production et de la distribution de l'énergie électrique". *Bulletin de la société française des électriciens*, Paris, April, 1948, pp. 173-85.

General study of the problems of the production and distribution of electric power in France in present circumstances, and the prospect for future development. The personal qualifications of the author, who is Director of Study and Research for the "Electricité de France" make his views exceptionally interesting and important.

320 BABONNEAU, Lucien. *Energie électrique en France*. Toulouse, Privat & Cie., 1948.

A descriptive review of steam and hyrdo-electric power generation in France. Copiously illustrated and with a number of statistical graphs.

321 BABONNEAU, Lucien. *L'Energie électrique en France*. Paris, Gauthier-Villars, 1948.

This amply illustrated work, published with the assistance of the "Electricité de France", describes "the epic story of the electricification of France"; it gives rather full details on the various modern thermal works and dams constructed and traces the development of France's remarkable electric network; it also contains brief notes on the sale of electric power and on its probable development. The author does not write for experts but for the general educated public.

BEARD, James A. See No. 253.

322 BLANCHARD, Raoul. *Les forces hydro-électriques pendant la guerre*. (Economic and social history of the world war - French series.) Publications of the Carnegie Endowment for International Peace. Paris. Presses universitaires de France, and New Haven (USA), Yale University Press.

This work, issued in 1922, is still of general interest. The author discusses the changes and progress of the French hydro-electric industry during the first world war. He shows how, under the impact of war, a source of energy that France, before all other countries, began to use in 1868, came to assume paramount importance under the pressure of circumstances, and how the work carried out during the war itself was instrumental in making up for lost sources of energy (northern coal mines) and in bringing about an industrial development that was stimulated rather than impeded by the close of the war. Mr. Blanchard quotes figures: in 1918, the forces that had been harnessed represented a 97 per cent increase over the existing in 1914. In addition, a considerable geographical extension of the sources of hydro-electric energy took place. Whereas in 1914, the Alps accounted for two-thirds of all such sources, after the war they represented only 57 per cent of a total which included the Pyrenees, the Massif Central, the Jura and the Basin of Aquitaine. We may judge for ourselves the extensive social changes brought about by this increase and territorial extension.

323 BORLASE, MATTHEWS & DRILHON, H. H. *L'électricité dans les exploitations agricoles*. Paris, J. B. Baillière et Fils, 1938.

The authors make the point that rapid progress in agriculture is impossible without extensive technical, economic and social changes and stress the prime importance of electricity for any such reform, on which all hopes of broad economic and social progress depend. They then give detailed consideration to the countless possible applications of electricity in farm work, suggesting many methods at that time very advanced. Full particulars are supplied on each of these applications: precise information on plants already available, statistics and numerous photographs. Now that French agriculture has been placed on a more up-to-date footing than in 1938, a new, modernized edition would undoubtedly be of great assistance to those wishing to direct technical progress in agriculture along the most rational lines.

324 CARR, T. H. *Electric Power Stations*. (2 vols.) London, Chapman &Hall, 1947.

A comprehensive textbook on the design and layout of central electricity generating stations. The first volume covers fundamentals of design, civil engineering, cooling water, coal and ash handling, boiler plant, pipework and turbines. The second volume deals with condensing plant, feed systems, alternators, transformers, switchgear, cabling, protection equipment, auxiliaries, and general matters of organization, testing and costs.

325 COURTIN, M. "Les emplois de l'énergie électrique dans les hôpitaux." *La France Energétique*, November-December 1943, pp. 329-32.

Paper showing the variety of applications of electricity in hospitals: lighting and heating, more particularly of operating theatres, involving special problems; laundering and sterilization of linen; destruction of dressings and organic refuse in electric incinerators; vertical transport (lifts for patients) and horizontal transport (wheeled stretchers in hospitals including several buildings); fire alarms, etc.

326 CREAGER, W. P. & JUSTIN, J. D. *Hydro-Electric Handbook*. New York, John Wiley & Sons Inc., 1950.

An exhaustive study of hydro-electric design and practice, covering hydrology, preliminary studies and economics, dams and dam construction, conduits and power houses, equipment and operation.

327 CURCHOD, A. *Réseau de distribution d'énergie électrique*. Paris, Dunod, 1934.

A comprehensive textbook on the generation of electricity in steam and water power stations and its transmission and distribution. Special attention is devoted to French legislation.

328 DARNAULT, P. *Régime de quelques cours d'eau d'Afrique équatoriale et étude de leur utilisation pratique.* Paris, Larose, 1947.

General particulars about French Equatorial Africa and the regimen of its major rivers. Possibility of making world-wide use of this enormous hydraulic power at present neglected, by local production of electric power to be conveyed in the form of direct current to Western Europe.

329 FELICE, J. de & DESSUS, G. *L'énergie électrique à notre service.* "Bibliothèque du peuple". Paris, Presses universitaires de France, 1942, 64 pp.

This small "popular" pamphlet is divided into two parts. The first deals with the problems of production, urban and rural distribution, and sale (cost price, rates charged) of electric power. The second considers the best conditions in which this power can be used (cost price and convenience) for lighting purposes (in homes, shops and workshops), for small domestic electrical apparatuses (refrigerators, washing-machines, heating appliances, stoves, etc.) and for electric motors used in small industries and handicrafts.

330 FLEMING, J. A. *Fifty Years of Electricity.* The Wireless Press Ltd., 1921.

A fascinating review, for the intelligent general reader, of some of the chief triumphs of electricity during half a century, written by the inventor of the thermionic valve.

331 FREMONT, M. *L'Utilisation des résidus urbains.* Lecture given at the Centre de documentation chimique, Maison de la chimie, Paris.

Analysis of the problem of garbage and of the solutions adopted: collection, means of evacuation and utilization (as manure) or destruction (by incineration, which, if the works are sufficiently large, may furnish a substantial supply of electric power).

332 GALL, Jean. *L'avenir de l'électrométallurgie et ses répercussions sur la consommation de l'énergie électrique,* 24 pp.

An exhaustive study of one basic aspect of the relation between the development of electric supplies and of metallurgy (special cases of aluminium and magnesium).

333 GÉRARD, G. *Hydro-Electric Engineering.* London, Sir Isaac Pitman & Sons, Ltd., 1949.

A treatise on the civil, mechanical and electrical aspects of hydro-electric schemes, with many photographs and diagrams and examples of several plants. There is a long chapter on tidal power.

334 GIGUET, M. *Le barrage de Génissiat et l'aménagement du Rhône.* Institut technique du bâtiment et des travaux publics, Série A, No. 14, 15 April 1947, 17 pp., 3 photographs.

The plan for harnessing France's resources in hydro-electric energy is intended to make good the deficit of 20 or 25 million tons of coal per year which paralyses her production. The Rhône is the most suitable French river for that purpose. Its harnessing could provide 13 milliard kWh a year, which represents a considerable fraction of French production (in 1946 the total consumption of power was 23 milliard kWh). An historical account of the Génissiat dam, which was begun in 1937. Present state of the work. The Seyssel and Donzère-Mondragon factories.

335 HENRY, Paul-Edmond. "L'aménagement du bassin de la Seine." *La Nature,* No. 3, 173, September 1949, pp. 257-62, 9 figs.

On a smaller scale, the Seine catchment basin upriver from Paris presents the same problems as does the Tennessee Valley, and could benefit from a similar solution. The picture of past efforts, present organization and future projects shows that the harnessing of the Seine basin would be highly valuable (as regards regularization of the flow, improvement of navigation, a contribution of some hundreds of millions of kW hours, irrigation, improvement of water supplies, tourist amenities, etc.).

336 LABADIE, Jean. "Du Rhône au Tennessee, l'équipement hydroélectrique et l'équipement monétaire solidaires de l'équation de Fisher Mc = pt." *Actualités Scientifiques et Littéraires,* No. 1062, Paris, Hermann, 1948, 115 pp., fig.

A study of the hydro-electric harnessing of the valleys in relation to financial outlay. An attempt is also made, in the interests of the Rhône project, to discover the fundamental reasons for American success in the Tennessee Valley. Difference between the structure of the "Compagnie Nationale du Rhône" and that of the American TVA. Financial outlay, and attempts to discover a French formula. Hydro-electric equipment and financial outlay are connected by the equation of Irving Fisher, one of the theorists of President Roosevelt's Brain Trust, who has expressed in a simple formula a quantitative theory for the full economic employment of money. Money, the most ancient, the most traditional and the most efficacious of catalytic agents, must again become a factor capable of directing collective evolution towards its natural goal, which is to offer the individual innumerable occasions of developing and not of diminishing his freedom, and the means of achieving this object.

337 LAURENT, René. *L'électrification de la maison moderne. Guide pratique de l'usager sur les emplois de l'électricité à la maison et dans ses dépendances. Le coin du bricoleur,* Lyons at the author's, 1946.

While electricity contributes to industrial progress, it is also the prime factor in any modernization of domestic equipment, and the needs of modern life bring about the rapid extension of its uses in the home. In describing those uses, in an elementary but precise fashion, the author addresses himself, not to theorists or technicians, but to the users themselves. This kind of popularization work deserves to be developed much more extensively, because science and technology can only be used rationally for the improvment of living conditions if every individual knows what possibilities are open to him and how modern technology should be applied in each particular case.

338 LEJAY, André. *L'utilisation domestique de l'électricité.* Doctor's thesis. Paris, A. Pedone, 1933, 205 pp.

This work was written at a time when production was expanding fairly rapidly, while the market was shrinking through under-consumption; its main purpose is to show how intelligent propaganda, combined with a rational economic policy, should considerably increase the demand for electric power and thus avert any crisis of over-production. The author briefly traces the background of the domestic applications of

electricity, of which he gives a fairly comprehensive list. Various statistics show that as the market was far from fully exploited, it would be possible, by fixing reasonable rates, modernizing technique and carrying out intensive propaganda, to raise the consumption of electricity even during an industrial crisis; such a policy could not fail to benefit French economy.

339 MALÉGARIE, Charles. *L'électricité à Paris.* Foreword by Ernest Mercier, Paris, Liége, Ch. Béranger, 1947, IV-707 pp. fig., pl., map, diagrams, bibliography.

History of the electrification of Paris. The problems are explained by means of a large number of detailed documents and technical, economic, legal and administrative reports. Two chapters, "Au service du public" (pp. 285-347) and "La lumière dans la cité" (pp. 348-412) tracing the history of lighting in public thoroughfares, deal more particularly with the importance of electricity in the home and the street.

340 MARTIN, René. *L'électrification du village français. Rapports présentés aux journées d'information syndicale du 31 mai, 1er et 2 juin 1944 (Syndicat professionnel des producteurs et distributeurs d'énergie électrique).* Paris, 1944, 20 pp.

A very interesting and well documented study, illustrated with two graphs and 14 maps, on the progress of electrification in the French countryside from 1939 to 1942; number of villages equipped with electricity, number of consumers, development of consumption in different regions and according to the dominant types of cultivation and agricultural industry. The various aspects of the problem of the rural consumption of electricity are very fully examined, and many lessons are deduced. Several other papers submitted to the "journées d'information syndicale", held on 31 May, 1 and 2 June 1944, are also of considerable general interest.

341 MARTINCOURT, J. *L'équipement électrique de la France.* 2nd ed., Collection "Que sais-je?", Paris, Presses universitaires de France, 1946.

This booklet is an elementary but clear account of the widely varying problems involved in the rapid development of electrical equipment in France. After dwelling on two new factors of paramount importance — the inauguration of the Planning Commission and nationalization of the production and distribution of electricity — the author shows how electrical power differs from other sources of energy. He then deals in turn with the technical and economic problems involved in both the production and distribution of electric power, with special reference to the features peculiar to the French market. After a brief review of the various applications of electricity, he concludes with a description of the probable development of electrical equipment in France and emphasizes the efforts that must be made in various fields if technical and social progress is to be speeded up.

342 MARTY, H. "Relations publiques et services de l'électricité." *Hommes et Techniques,* No. 72, December 1950, pp. 19-24.

In this statement, which is based on his previous studies and experiments, the author brings out the main lines of what the public relations for electrical companies and services should be. Public Relations are more than mere propaganda; they are the expression of a feeling for business which, in the psychological field, would act rather as does the dispatcher in the transportation of energy. There is too great a time-lag between "psychological" activity and technical progress. Means must be found of creating an atmosphere conducive to good relations between producer and consumer.

343 MICHEL, Léon. *L'électricité en Belgique,* Liége, Ecole supérieure des sciences commerciales et économiques, 1937, 306 pp., fig. and table.

Economic and financial study. The different aspects of the production, transport, distribution and utilization of electricity in Belgium and the financial organization of electricity companies and electro-holdings. Chapter V, dealing with the utilization of electricity, supplies extensive information on the electrification of Belgium and on the consumption of electricity according to its different uses.

344 RANDALL, W. R. *The Romance of Electricity* London, Sampson Low, Marston & Co., Ltd., 1931.

A popular account covering electricity supply, communication, lighting, traction, the home, the countryside, and many other facets of the subject.

345 ROUX, Edmond. *Energie électrique et civilisation.* Bibliothèque de philosophie scientifique, Paris, Flammarion, 1945, 266 pp.

Electric power is a basic factor in modern civilization; its influence is felt in every field of human activity, both material and intellectual. It possesses many advantages over other forms of energy. It can be distributed satisfactorily in any place and its use is speedily being generalized for all purposes, from the home which it lights, heats, cleans and to which it brings music, to the railways and large factories. Study of the technical, financial, economic, social and legal facets of the electrical industry. All problems raised are considered in close relation with the repercussions on social life (wages, prices, leisure, comfort, etc.), that have resulted or may result from a country's electrification, for the most perfect organization of any branch of economy is valueless unless it helps to improve the lot of mankind.

346 SCHOKLITSCH, A. *Hydraulic Structures.* (2 vols.) New York, American Society of Mechanical Engineers, 1937.

Volume I deals with meteorology, hydrology, hydraulics, soil mechanics, water supply and sewage. Volume II is on dams, hydro-electric plants, and waterway engineering.

347 SYLVESTRE, V. & BLANCHARD, Raoul. "Contribution à l'histoire de la houille blanche et la part de la Savoie dans la conquête de l'énergie hydroélectrique." *La Houille Blanche,* September 1946.

Essay on the origins of the use of water-power as a form of energy. It seems that in very remote times water channels were used as sources of energy, before they were used for irrigation purposes. The Bazacle mills at Toulouse foreshadowed, at the beginning of the eighteenth century, certain types of turbines, etc.

348 TAYLOR, E. V. *Utilization of Electric Energy.* London, English Universities Press, 1946.

A technical book covering stationary electric drives, traction, heating and welding, electrolytic processes, lighting, and the economics of the use of electricity.

349 TIBERGHIEN, E. "La production et la distribution de l'électricité en Belgique." *Revue française de l'énergie*, No. 11, July 1950, pp. 325-37.

Electric power plays an important part in the economy of such a heavily industrialized country as Belgium. The problems which it raises bear on the fields of law (legal regime), technique (production), economy (co-ordination, imports and exports), administration (distribution), industrial, commercial and social life (consumption, tables of electricity consumption in Belgium according to its uses in the home, in handicrafts, in industries, etc.), and professional organization.

350 VARLET, H. "La production et la consommation de l'énergie électrique en France." *Revue française de l'électricité*, No. 1, September 1949, pp. 3-12, 4 figs., No. 2, October 1949, pp. 52-9, 2 figs., No. 3, November 1949, pp. 67-71.

A detailed study of the annual, seasonal (differences between summer and winter), daily (consumption on Sundays) and hourly (the problem of peak hours) consumption in France and particularly in Paris. The question of electric heating. The problems of thermal and hydraulic equipment.

351 WEITZ, B. I. *Electric Power Development in the U.S.S.R.* London, Lawrence & Wishart, 1937.

A compilation of papers given to the World Conference on Electric Power Development held at Washington, describing the planning and development of steam and hydro-electric stations in Russia.

COLLECTIVE OR ANONYMOUS PUBLICATIONS

352 Notes et études documentaires: *Les problèmes de l'eau en Afrique du Nord, 1re partie, L'équipement hydraulique du Maroc.* "La Documentation française", No. 1, 170, 1949.

After defining the general hydrographical characteristics and climate of Morocco, the author gives an account of Moroccan dams already built, in process of construction or planned; he then discusses the supply of drinking water to towns, hydraulic engineering for agriculture with the technical, legal and economic problems involved, and lastly considers the general conditions required for the development of hydroelectric production and the nature of present equipment.

V. *Nuclear Energy*

353 ANDRADE, E. N. da C. *The Atom and its Energy.* London, G. Bell & Sons, Ltd., 1947.

An explanation of nuclear physics in the simplest language.

354 BACHER, Robert F. "The Hydrogen Bomb". *Bulletin of the Atomic Scientists*, Vol. 6, No. 5, 1950, pp. 135-38.

A detailed analysis of the new weapon in terms of its military effectiveness. Mr. Bacher thinks that the public has made a mistaken judgment about the value of the bomb, because of the excessive secrecy which has been observed, and believes that other military developments are more important for security. He asks for more information to be released so that the average citizen may be in a position to make an intelligent decision on such important matters of policy. (This article was reprinted in the (British) *Atomic Scientists' News*, Vol. 3, No. 6, pp. 134-5, 1950.)

355 BLACKETT, P. M. S. *Les conséquences militaires et politiques de l'énergie atomique.* Translated from the English by the "Association Française des Travailleurs Scientifiques", foreword by E. Bauer, Paris, Albin Michel, 1949, 301 pp., Bibliography (mainly English and American).

A rational basis for British policy with regard to atomic energy may be sought in an exact knowledge attempts to foresee how the establishment of a control of the probable effect of atomic weapons and by system would affect relations between the great powers. The latter's military situation has been affected by the invention of atomic bombs and would be changed still further by their use. The political and strategic influence of atomic bombs would depend on their destructive power, the possibility of providing defence against carrier aircraft or rockets and the passive defence measures adopted by each country. These different factors may be assessed by considering the experience gained in the 1939-45 war and the possibilities of technical development. It is not unlikely that America will soon possess an infinitely more deadly weapon than the present atomic bomb. Its use in a war against the U.S.S.R., which does not appear to be counting on the use of atomic weapons, would be more disastrous for Western Europe, which would in all probability be used as a base for operations, than for the main belligerents. The work concludes with a detailed account of the control of atomic energy and of the stand taken by the U.S.S.R. and the United Nations during negotiations. Extracts from the first Report of the Atomic Energy Commission of the Union of Soviet Socialist Republics, dated 11 June 1947, extracts from the Compton and Finletter Reports and a statement on the problem of atomic energy adopted by the French Association of Scientific Workers on 17 July 1948 are appended.

356 BOUTARIC, A. *Au seuil de l'ère atomique.* Bibliothèque de philosophie scientifique, Paris, Flammarion, 1947, 210 pp. fig.

Results of research in the fields of the structure of matter; nuclear reactions as sources of energy; past (military) and future (peaceful) uses. Possibility that the various sciences and industries peculiar to the atomic era may soon transform human life.

357 BOUZAT, Albert. *L'énergie atomique.* Series No. 317. Paris, "Que sais-je?", Presses universitaires de France, 1949, 128 pp., fig.

The utilization of atomic energy is a decisive step toward domination of the Universe. Elementary data on the structure of matter and on atomic energy. Composition of the atom. Transmutation of elements and nuclear power. Chapter IV is devoted to the uses of nuclear energy liberated by the impact of neutrons. Uranium fission as the source of nuclear energy. The atomic pile and how it works. Description of several experiments connected with the atom bomb. Superiority of nuclear over other sources of energy. Minerals and their geographical distribution.

358 DANIELS, Farrington. "Atomic and Solar Energy." *American Scientist,* Vol. 38, No. 4, October 1950, pp. 521-48.

This article contains a comprehensive discussion of the principles and possibilities of these two sources of energy, written by the distinguished Professor of Physical Chemistry at the University of Wisconsin. Possible sources of heat and power that may be available to our civilization after the exhaustion of our mineral deposits are reviewed. A programme of decentralized research in the utilization of solar energy for peacetime purposes is proposed and examined.

It is concluded that "in the foreseeable future it seems likely that atomic power will be utilized in large central stations involving heavy capital investments, and that solar power may well be employed in simpler decentralized units involving less expense. Practical atomic and solar power will come slowly, but both have considerable promise. This promise can be realized only with the help of vigorous, sustained research programmes. Atomic energy for military purposes was developed with the aid of *two billion* dollars in three war years under conditions of centralized authority and secrecy. It would be interesting to see what might be done with *two million* dollars in three years for the greater utilization of solar energy for peaceful purposes under conditions of decentralization and independent initiative, aided by rapid publication of results".

A useful bibliography is appended.

359 DERIBÉRÉ, Maurice. *Expériences atomiques.* Collection "Problèmes", Paris, Editions Elzévir, 1946, 63 pp., 7 figs., 4 pls. Summary bibliography.

This short popular pamphlet begins with a few pages on the peaceful potentialities of atomic energy, and recounts the experience gained at Los Alamos, Hiroshima, Nagasaki, and the Bikini atoll (history, effects, future prospects).

360 DERIBÉRÉ, Maurice. *L'énergie atomique.* Collection "Problèmes", Paris, Editions Elzévir, 1945, 62 pp., 4 figs. Summary bibliography.

A short popular pamphlet. History of the discovery of atomic energy, its development during the war, work in France and Germany, the experiments made in New Mexico in 1945, the atomic bomb and its effects. The atomic bomb, against which it is, in the author's opinion, not impossible to develop protective devices, is not, however, the only means of using the energy locked in the atom. When coal and oil deposits are giving out, the possession of atomic energy offers fascinating possibilities for the future. Admittedly, the return yielded or the cost of production, which comes to the same thing, imposes many restrictions on the employment of this energy, but, leaving aside the suppositions of journalists, the inauguration of steam generating stations run on uranium may be contemplated in the near future, and the era of interplanetary travel is possibly not far off.

361 DERIBÉRÉ, Maurice. *L'Uranium.* Collection "Matières Premières", Paris, Editions Elzévir, 1946, 62 pp., 2 maps. Bibliographical references.

Uranium, the basic source of nuclear energy, has a special place in the periodic classification of the elements. After a brief description of the properties of uranium and its similarities to radium, the author embarks on the question which forms the main subject of this well-documented little booklet—that of uranium ores and deposits, and their distribution in the world. Uranium is not found in the free state, but in the form of various compounds: oxides and hydroxides (pitchblende, etc.), uranates (curite, etc.), carbonates (rutherfordite, etc.), silicates (uranophane, etc.), phosphates (uranite or autunite, etc.), sulphates (voglianite, etc.), arsenates (troegerite, etc.), vanadates (carnotite, etc.) and various other more or less complex rare earths. Uranium was detected for the first time, in 1789, in pitchblende from St. Joachimstal in Bohemia, and in 1907, after the discovery of radium by the Curies the first factory for the extraction of radium was set up in the vicinity of that mining centre. In 1914, France was the only country producing radium, but international competition soon developed. Since 1939, Canada has dominated the world radium market. This short popular study ends with a brief survey of the prospects before France and the distribution of her main deposits of uranium.

362 DESSAUER, Friedrich. "L'énergie atomique et ses applications, exposé scientifique présenté simplement et réflexions sur la valeur humaine des nouvelles découvertes." A translation of the second edition by B. Susz. "Histoire et Société d'Aujourd'hui" series. Neuchatel, Paris, 1948, 301 pp., fig., portraits.

A general outline of the question of atomic energy and its uses, and an attempt to form a critical appreciation of their value for mankind. The moral and intellectual position of humanity has been transformed by technical progress, but the problem is to determine whether men will be capable of discharging responsibilities that increase in proportion to their power.

363 DUCROCQ, A. *Les horizons de l'énergie atomique.* Collection "Science et Humanité", Paris, Calman-Lévy, 1948, 280 pp.

The author proposes to survey present possibilities in connexion with the application of atomic energy, drawing attention to the difficulties which have been encountered and outlining the essential features of atomic machines as at present contemplated by modern technology. After a description of the structure of the atom, atomic energy, uranium piles, and the manufacture of plutonium, the author embarks on a study of the industrial potentialities of this new form of energy (electric generating stations, locomotives and submarines, rockets, jet engines, etc.). The atomic bomb may not be the major weapon in any future war. While the bomb may inflict 10,000 times as much damage as an ordinary bomb, the cost of producing it is a 100,000 times as high, so that it

may not be an economic proposition. The effects of gamma radiation on living organisms are known only from those of the bombs dropped on Japan and from the Bikini experiments. No official reports have ever been issued, but it is known that the destructive effect is selective and that not all functions are equally affected. Some day it will be possible to determine what is the frequency of radiation to which a particular organ is susceptible. This opens up extraordinary possibilities in medicine (cancer, prolongation of life, sleep) or biology (artificial mutation). Will the atomic age be an industrial paradise? World supplies of uranium may be estimated at 50 to 150,000 tons. In 1940, 2,000 tons of this mineral were already being extracted each year, and it seems unlikely that the uranium supplies of the planet can keep the piles going for more than a few decades at most. Uranium fission, however, represents only the first stage on the way to the atomic era; it may be replaced by any other exothermic nuclear chain reaction, which will provide energy for the world of tomorrow.

364 DUPUY, Gaston. *Radium, radioactivité, énergie nucléaire.* Series "Que sais-je?", No. 33, Paris, Presses universitaires de France, 1949.

This booklet is primarily intended to be a popular scientific work; the social repercussions of the discovery of radio-activity and of nuclear energy are given only summary mention, the author devoting barely a few pages to the uses in medicine of the phenomena under consideration. More space is given to the uses of "induced radio-activity", resulting from research carried out by Frédéric and Irène Joliot-Curie. Of these, the only one of really topical importance is the atomic bomb, for the atomic pile, which is also described, can have no more than theoretical significance for the time being. The author hopes, as we do, that "the huge reserves of energy which for a long time have been suspected to exist in the tiny world of atomic nuclei may be utilizable in the near future". Some details on proposed uses might have been an advantage.

365 GENAUD, P. *L'arme atomique.* Paris, Dunod, 1950, 416 pp., 155 figs., 1 pl.

This work has been written "as a contribution to knowledge of the nature and the gravity of the danger of atomic warfare". It is a factual account liberally illustrated with photographs, but unfortunately it contains no bibliographical references. All the information has been collected either in England and the United States of America or from the survivors of the Japanese cities bombed in 1945. The first part gives a simple description of the physical bases of the atomic weapon. The second part deals with the effect of atomic explosives: mechanical effects on buildings and living creatures (direct effect of blast), heat effects (flash or fire burns), radioactive effects (on the tissues, the genital glands and descendants, canceration, etc.). Out of 80,000 deaths at Hiroshima, 60,000 occurred on the day of the bombing, and 12,000 in the two following weeks (effect of blast, radiation and, above all, burns). In the next five weeks, deaths were due mainly to injuries from radiation (sub-acute form of the syndrome of those exposed to the rays: loss of hair, fever, haemorrhages, etc., followed by infectious complications). From the third month on, a period begins in which signs of active recovery can be seen in the injured organs. The effects on descendants, and secondary canceration, are the subject of investigations by American committees under the National Research Council. In a final section, the technical and political aspects of defensive measures and methods are considered.

366 GOLDSCHMIDT, B. "Le Problème du plutonium." *Atomes*, July 1949, p. 227.

The author, a scientist and senior government official responsible for the French production of uranium, plutonium and fission products, describes the position of French production; he emphasizes that plutonium, far more than gold, is the measure of a society's power and wealth. He states that "once a country has succeeded in producing a stock of something near 50 kilogrammes of plutonium, the technical problem gives way to the social problem of determining how to use the pure nuclear fuel—for destructive or for peaceful purposes".

367 GOODSON, C. *The Science and Engineering of Nuclear Power* (2 vols.). Cambridge (U.S.A.), Addison-Wesley Press, Inc., 1947.

A textbook on the fundamentals of chain-reacting systems and their industrial application. Volume I is a general survey and volume II deals with specific aspects of nuclear engineering.

368 JOUVE, Géraud. *Voici l'âge atomique.* Paris, Société des éditions *Franc-Tireur*, 1946, 279 pp.

This book is described as the work of a journalist, or rather chronicler, whose object was to compress into some 250 pages the history of the first weeks of the atomic era and to show the reactions and anticipations of scientists, industrialists, visionaries and even charlatans. The essay is presented in the form of an unbroken account of events, supported by numerous quotations from newspapers and periodicals (16 July 1945-24 January 1946).

369 KAHAN, T. and MAGNAN, C. "L'énergie atomique et ses applications." Preface by Mr. Louis de Broglie. Collection "Sciences d'aujourd'hui", Paris, Albin Michel, 1949, 260 pp., 58 figs., 16 pls.

This book, written by two specialists on the phenomena of nuclear physics, opens with a general account of our knowledge concerning the atomic structure of matter, the classification of the elements, the structure of electricity and light, wave mechanics, methods of detecting and observing various particles and radiations, nuclear energy and the structure of atomic nuclei, and the various types of apparatus with which transmutation can be brought about. This account, in which the mathematical complications are kept to the minimum, but which is nevertheless, scarcely to be comprehended by any but specialists, is followed by an account of the history of the manufacture of atomic piles. The first research carried out by French physicists, and in particular by F. Joliot, which was interrupted by the defeat in 1940, was resumed by the two Americans, Fermi and Szilard, who were a little behind the French in their work. On 2 December 1942, the first divergent chain reaction began; for the first time nuclear energy was released in such quantities that industrial use could be contemplated. The English pile at Harwell was brought into use in August 1947, and the French pile at Châtillon only a year later, in spite of the forced inactivity of French research until 1945. After a detailed historical account of the production of the first atomic bombs in America, the authors turn to the question of protection against atomic bombs, which, it seems to them, is unlikely to be possible. They consider that the only effective system of defence would be to disperse the inhabitants of the country evenly throughout the whole of the habitable areas, which would produce a more or less serious paralysis of industrial production. A well-prepared country might no doubt avert total defeat but could not save itself from unprecedented destruction. In conclusion, consideration is given to certain industrial uses of atomic energy: powerful gas turbines, atomic locomotives and ships, industrial and biological application of radio-active isotopes.

370 NAHMIAS, M.E. "L'énergie atomique et son utilisation militaire." Paris, Ed. de la *Revue d'optique théorique et instrumentale,* 1946.

Translation of the 1940 Turner report and of American and British reports of 1945, the longest being that prepared by the American Professor H. D. Smyth. These papers contain the first official information on all the work carried out by Allied physicists with a view to releasing nuclear energy for military purposes. They show the development of theoretical and technical knowledge in nuclear physics, discuss the political implications of the problem and point the way to future peaceful applications of atomic energy.

371 NAHMIAS, Maurice E. *Artillerie atomique.* Second edition, Paris, Liége, C. Béranger, 1947, VIII-202 pp., pl.

There are not two kinds of research, one "applied" and the other a purely intellectual process; all research is one, though it takes many forms; and the work endeavours to illustrate this co-operation in the field of science. A description of the tests carried out by physicists, mathematicians and chemists to clarify experimentally the mysterious phenomena occurring in the nuclei of atoms. All projectiles, infinitesimal components of matter, are for the scientists subjects for study and means whereby to explore the material world to its depths. Practical use, for both peaceful and lethal purposes, has already been made of these things.

372 PREGEL, Boris. "L'énergie atomique et l'abondance." Paris, *Les Echos,* Les presses modernes, 30 pp., 1948.

An *Echos* lecture given on 6 October 1948. Economic results of atomic energy: greater independence of industry, greater, quicker and cheaper production. Men will become less and less dependent on their own labour, fixed sources of power and natural resources. There will be less difference between the possible outputs of highly industrialized and those of technologically backward countries.

373 RICHARD-FOY, Robert. *Voyages interplanétaires et énergie atomique.* Preface by Maurice de Broglie. Paris, A. Michel, 1947, 79 pp., fig.

The use of atomic energy may one day enable us to travel between planets. What source of energy will ensure jet propulsion through space, and what atomic engine will be used for inter-planetary travel? To such questions recent discoveries in the field of atomic energy provide theoretical answers; but inter-planetary travel presupposes conditions that as yet are far from having been fulfilled.

374 SAINTE-LAGUË, André & SERVAN SCHREIBER, Emile. "De l'énergie atomique au socialisme distributif." Paris, *Les Echos,* Les presses modernes, 1946, 31 pp.

Echos lecture of 18 December 1945. The development of sources of energy, and especially of atomic energy, can lead either to the destruction or to the Golden Age of humanity. A statement—in relation to that postulate—of the theory of plenty and a description of distributive socialism.

375 SAVORNIN, André. "La géographie de l'énergie atomique." *La revue de géographie humaine et d'ethnologie,* first year, No. 4, October 1948-October 1949, pp. 3-24, 3 maps, 15 photographs.

Is atomic energy to be employed for the purpose of destruction or for peaceful purposes so that future generations may live a better life? What effect will its application have on the use of other sources of energy? We cannot yet know the answers to these questions, but one thing is already certain: that the exploitation of atomic energy is already beginning to make its own mark on the face of the earth. Mines, industrial plants and communities are coming into being in various countries in the world, similar or different in character. In France, the 400 or 500 people working at Châtillon have not yet made any appreciable impression on the countryside. This will no longer be true when the centre at Saclay is completed. We shall then see a new scientific city growing up in an area which at present offers not even the most elementary living accommodation, and which has no electric power source, just as, in the past, the industrial cities of the North grew up as new deposits were discovered. Only during wartime, however, are enormous cities like those at Hanford and Clinton likely to come into being. There is no doubt that, as the use of atomic energy is developed, *the number of workers employed in the production of the raw materials from which energy is generated will become much smaller than at present.* We have not yet reached this stage. The first result in France or its overseas territories has been to stimulate the development of new research centres or even of mining enterprises, in conditions comparable to those of the "gold rushes". The psychological and social repercussions are, or will be, numerous. In three new mining centres in France already, the superposition of a new industrial type of life on the peaceful life of the countryside may be observed. The article concludes with a study of atomic energy from the economic point of view in the United States of America, Great Britain, Belgium and the Belgian Congo, the U.S.S.R., and Czechoslovakia, and a brief survey of the probable influence of the development of atomic energy in the world.

376 THIBAUD, Jean. *Puissances de l'Atome.* Paris, Albin Michel, 1950, 272 pp., 23 figs., 8 pls.

The first part deals scientifically with the splitting of the atom, chain reactions and uranium piles. The author next considers the power aspect of the new techniques, particularly from the economic standpoint; he discusses the assessment of costs of production. The book also reproduces a number of official texts (U.S.A. plan, theses on a world government published by a group of American universities, etc.). It ends with considerations of the moral consequences of the atomic revolution.

377 VAUCOULEURS, Gérard de. "La conquête de l'énergie atomique." *Actualités scientifiques et industrielles,* Paris, Hermann, 1946.

A record of 50 years of research on nuclear physics and chemistry, from the discovery of the first "uranium rays" to the development of the atomic bomb. The first part is a detailed analysis of work in connexion with uranium fission, before and after its recognition, until early in 1940. The second part summarizes official English and American reports rearranged in chronological order, retraces the various stages in the production of the atomic bomb between 1940 and 1945, and deals more particularly with the scientific problems arising out of this development. The report concludes with reflections on the threat to mankind inherent in the mastery of atomic energy if the leaders of the world continue to seek a solution for their internal problems in a policy of imperialistic, economic or ideological expanson; the ultimate solution must be energetic political action on the part of research workers, scientists and technicians, who are responsible for the progress of civilization.

378 VIGNERON, Leopold & CHASTEL, Raymond. *L'énergie atomique, promesse ou calamité?* Preface by Air-General Plagne. Paris, Editions de France-documentation, 1949, 16mo. 128 pp.

An attempt to inform the non-specialized public about the atomic question in general. History of nuclear discoveries, atmoic structure of matter, radio-activity and transmutations, techniques and apparatus of nuclear physics. The concluding part of the work is devoted on the one hand to the atomic bomb and, on the other, to the industrial and peaceful uses of atomic energy. Some data on the international political aspects of atomic energy.

COLLECTIVE OR ANONYMOUS PUBLICATIONS

379 *Atomic Energy: Its International Implications.* London, Royal Institute of International Affairs, 1948.

A discussion by a Chatham House study group.

380 *Atomic Weapons.* A symposium. Labour Monthly, Vol. 32, No. 4, pp. 157-64, 1950.

Answers to the question, "What steps do you think should be taken to prevent the use of atomic bombs in all forms, uranium, and later developments?", are given by the Rev. Leslie E. Cooke, General Secretary, and the Rev. B. C. Plowright, Secretary, the Life and Work Committee of the Congregational Union of England and Wales; Lady Parmoor, Society of Friends; Gerald Bailey, Director of the British National Peace Council 1930-49, and Acting Chairman of the International Liaison Committe of Peace Organizations; Professor J. D. Bernal, F.R.S.; Fred Longden, Member of Parliament for Birmingham, Smallheath; Dr. Joseph Needham, F.R.S., and Dr. Dorothy Needham, F.R.S.; Dame Sybil Thorndyke; Dr. E. H. S. Burhop, Association of Scientific Workers, and Secretary of the Atomic Sciences Committee; Dr. G. O. Jones, Queen Mary College, University of London; Rutland Boughton; and Douglas Goldring.

381 JOLIOT-CURIE, F., KOWARSKI, L., LE MEUR, E., SURDIN, M., ERTAUD, A., GOLDSCHMIDT, B., GUÉRON, J., STOHR, J. A., & ECHARD, R. "La première pile atomique française." *Atomes,* special number, February, 1949.

The authors of these articles present different aspects of the new problems raised by the first French atomic pile. Mr. Joliot-Curie emphasizes that the French Government intends to use the pile exclusively for providing artificial radio-elements for modern biology and industrial research. He recommends that the public authorities should fully realize the importance of science and technology for every nation desirous of freedom and happiness.

382 *L'Age atomique.* Special number of *Science et vie* prepared in collaboration with Maurice E. Nahmias, December 1950, 186 pp.

An historical study, *Naissance de l'âge nucléaire* ("Birth of the Nuclear Age"), articles on the constitution of matter, atomic piles and bombs, fissile raw materials, uranium, nuclear engines (power stations, ships, aeroplanes, rockets), the industrial and medical uses of radio-isotopes, atomic warfare, etc.

383 *L'Energie atomique et la politique américaine.* Translation of official and unofficial speeches. (International Series, Carnegie Foundation. European Centre) Paris, Hachette, 1946, 112 pp.

Official statements by President Truman (6 August 1945) and Secretary of Defense Henry L. Stimson on the atomic bomb. Various other messages, official and unofficial statements and addresses on future atomic energy control and United States policy.

384 *L'Energie atomique et son utilisation militaire.* Official documents: British report, United States report, by H. D. SMYTH, monograph by L. A. TURNER, translated by M. E. Nahmias, introduction by Georges Guadet. Edition de la *Revue d'optique théorique et instrumentale,* Paris, 1946, VII-298, pl.

A historical memorandum on the British research and organization which went into the making of the atomic bomb. A study of nuclear fission. The official American report on the use of atomic energy for military purposes.

385 *The Hydrogen Bomb.* A Symposium. Special issue of *Atomic Scientists' News,* Vol. 3, No. 4, 1950.

Opinions on the hyrogen bomb are given by Prof. Kathleen Lonsdale, F.R.S., University College, London; Prof. Sir George Thomson, Imperial College, London; Prof. R. E. Peierls, F.R.S., University of Birmingham; Dr. E. H. S. Burhop, University College, London; Prof. H. S. W. Massey, F.R.S., University College, London; Dr. W. D. Allen, Atomic Energy Research Establishment, Harwell; and Dr. G. O. Jones (then at the Clarendon Laboratory, Oxford).

VI. *Other Sources of Energy: Wind, Tides, etc.*

386 AILLERET, P. "L'énergie éolienne: sa valeur et la prospection des sites". *Revue générale de l'électricité*, March 1946, pp. 103-8.

Economic implications of the use of the wind's energy. Determination of the value of the energy that can be derived annually by subjecting 1 sq. m. to the action of the wind. Programme of the Technical Committee on Wind Energy.

387 AILLERET, Pierre. "L'énergie des marées". *Sciences*, 1947, (IV-15), pp. 352-61.

Lecture on the possible use of tidal energy in France, particularly in the estuary of the Rance and the bay of Mont St.-Michel.

388 AUBERT DE LA RUE, E. *L'homme et le vent*. Collection "Géographie humaine", Paris, Gallimard, 1940, 216 pp., 32 pls., and bibliography.

Several chapters of this treatise on human geography are devoted to wind as a source of power. Of all the natural forces, wind was certainly the first to be exploited by man. For centuries, wind was mainly used for propelling sailing-ships and windmills, both of which had almost completely disappeared at the end of the nineteeth century. But recently there has been a tendency to revert to this inexhaustible form of energy. The use of the wind-wheel is rapidly being adopted in Europe (France, Germany), America (United States, Canada, Argentina), Australia and North and South Africa, particularly in the arid regions, where it is used for pumping water for irrigation. In Australia, U.S.S.R. and France, plans for using wind-power on an industrial scale are now being considered.

389 CHAMPLY, René. *Les moteurs à vent*. Dunod, Paris, 1933, 270 pp., fig.

In addition to its highly interesting accounts of the first practical uses of wind power and of the important part played by wind mills in various countries, more particularly the Netherlands, this work discusses all the different types of wind engines, classifying them according to their principles and possible uses. The author stresses the basic importance of wind power, providing as it does an immense reserve of energy which is seldom drawn upon.

390 DEBES, M. *L'Utilisation de l'énergie des marées*. Institut technique du bâtiment et des travaux publics, Circular, series K, No. 11, April 1945, 17 pp., 18 figs.

Report on the present position. Merits (abundance and annual constancy) and demerits (discontinuity) of the utilization of this form of energy. Technical and economic difficulties. Proposed solutions. Main sites of works for the utilization of tidal energy in France (plans and studies). Need for France to exploit this new source of energy as speedily as possible and to proceed beyond the experimental stage. Short bibliography.

391 DUBERTRET, Paul. "La pompe à chaleur". *La revue générale du froid*, May 1949, pp. 379-84.

After some theoretical considerations on the principle of heat pumps, the author considers the conditions and possibilities for the use of these new thermal units, which are unfortunately so expensive to produce that they can only be used in a limited field. A number of interesting plants which have been set up in Switzerland provide material for discussion.

392 FICHOT, E. *Les marées et leur utilisation industrielle*. Series "Sciences et civilisation". Paris, Gauthier-Villars, 1923, VI-256 pp., fig. Bibliography.

After discussing the ocean's wave-motion, and the formation and propagation of tides, the author deals with the problem of utilizing the inexhaustible energy that might be derived from tides in certain favourable coastal areas. The two most important features of tidal energy (large capacity of natural basins and wide range of tides) are to be found along the French Atlantic and Channel coast. The equipment of factories using tidal energy presents tremendous, but not insuperable, difficulties. There is a very large store of energy. It would be possible to establish a production cycle, but the supply of energy would be irregular.

393 FINCH, W. C. *Watermills and Windmills*. Rochford (U.K.), C. W. Daniel Co., 1937.

A historical survey of the rise, decline and fall of watermills and windmills as portrayed by 410 examples, of which few remain, taken in Kent.

394 GIBRAT, R. & THIBAUDIN, R. *Notes sur la production d'énergie électrique au moyen des marées*, 63 pp., 36 figs.

A very well documented study consisting of a general account of the question, a consideration of the various schemes for the utilization of tidal energy, particularly the plan for the tide-powered factory in the estuary of the Rance and finally some general considerations on future possibilities.

395 GOGUEL, Jean. *L'utilisation de l'énergie interne du globe*. Lecture given on 5 December 1950 at the Centre de perfectionnement technique, Maison de la chimie, Paris.

Survey of the possibilities of using the thermal energy of the earth (latent heat stored in rocks, hot springs, hot steam discharges, etc.,). The author considers that only isolated results could be achieved in the utilization of this energy, which would fall far short of the needs. Nearly all sources of energy actually used to date are derived directly or indirectly from the sun's energy, the earth being only a support for us: "On the whole, it is in our interests to keep it an inert support."

396 HAMMOND, Rolt. "Harnessing the Tides: Is it Practicable?" *Discovery*, Vol. XI, No 11, 1950, pp.355-58.

The history of tidal power schemes in Great Britain is briefly sketched. Variability of output in place and time is a major difficulty, and constitutes the chief reason why tidal power has not yet developed on a large scale. Means for circumventing some of the difficulties are mentioned. The proposed Severn Barrage installation, with turbines to operate at around 30,000 hp., is described; if built, it would save about one million tons of coal per annum. Other proposed tidal schemes in Canada, the U.S. and France are mentioned.

397 HAUDRICOURT. "Les moteurs animés en agriculture. Esquisse de leur emploi à travers les âges." *Revue de botanique appliquée et d'agriculture coloniale*, Paris, XX, 1940.

An historical study.

398 JARLAN, Henri. *Le soleil et son rayonnement.* Collection "Que sais-je?", Paris, Presses universitaires de France, 1946, 126 pp., fig.

This work, though elementary, gives a thoughtful account of the subject; the first part deals with the composition of the sun and its apparent movement, and the second part with the sun's rays. After discussing the physical properties of these rays, the author dwells on their vital physical and biological importance. He shows how all sources of energy already used or capable of being used on the face of the earth are derived directly or indirectly from solar energy. He also emphasizes the physiological effects of these rays and concludes with an analysis of the various procedures for capturing the sun's energy direct.

399 LANOY, H. *Les aéromoteurs modernes, la production d'énergie électrique par groupes éoliens*, Foreword by L. Barbillon, 2nd edition. Paris, Girardot, 1946, 192 pp., fig., maps. Bibliography.

The characteristics of the wind in France; the history of its utilization as a source of mechanical or electric power. Basic theoretical considerations on the utilization of the wind's motive power. Different types of wind motors. Details of new plants in the United States of America and the U.S.S.R.

400 MOREAU, Georges. *Etude sur l'utilisation des marées en France.* Paris, Delagrave, 1931.

Although published some time ago, this report, primarily intended for students, retains considerable documentary value, since the author gives precise details on the various possibilities of utilizing tidal energy and describes various practical schemes for the purpose. Though little progress has since been made towards the solution of the problem whose theoretical and practical aspects he discusses there is no doubt that greater interest is being taken in the matter and the author's very apt remarks on the need for a thorough general study and on the tremendous possibilities that would be opened up by a rational utilization of tidal energy, particularly in France, have certainly helped to win over many sceptics.

401 NIZERY. A. & NISOLLE. L. "Où en est l'énergie thermique des mers?" Brussels, *Energie*, May-June 1949, pp. 777-86.

An historical survey of work and research on the use of the energy of the sea: first studies and experiments (1926-36), new methodical research (1941-47), study, experiment and work in preparation for the building of the pilot-factory at Abidjan, where it will be possible, for the first time, to make use of the thermal energy of the sea.

402 NIZERY, André & NISOLLE, Léon. *Etudes sur l'énergie thermique des mers.* Paris, Hôtel de la société des ingénieurs civils de France, 1949, 50 pp., fig., pl.

Text of two lectures. Fresh research has been carried out on the thermal energy of the sea, i.e., the latent energy resulting from the proximity of two enormous water masses with very different temperatures: surface waters and deep waters. Study of the thermodynamic cycle used. Technical problems and economic aspects of the question. Possibilities in tropical and equatorial countries and the problem of the progressive development of power consumption in those countries. The large amount of energy that could thus be quickly produced might be absorbed by the establishment of new industries: chemical industries using sea water (soda, bromine, chlorine, magnesium), drying and freezing plants for the conservation and processing of local food products, etc.

403 PUTMAN, P. C. *Power from the Wind.* New York, D. van Nostrand Co., 1948.

A summary of six years' experiments on the 1,250 kW wind turbine installed on Grandpa's Knob, Rutland, Vermont. Costs are given in a section on the economics of wind power.

404 ROMANOVSKY, Vsevolod. *La mer, source d'énergie.* Series "Que sais-je?", No. 431. Paris, Presses universitaires de France, 1950.

The author deals with the three main forms of sea energy: thermal, tidal and wave energy. He dismisses the latter as a mere scientific curiosity, the industrial use of which would not be a paying proposition, after referring to the main tests carried out, mainly in Monaco and Biarritz. These and other experiments all failed owing to the irregularity of the waves and to their erosive properties.

The results of experiments in the utilization of thermal energy deserve closer attention. These tests have been carried out in Abidjan on the Ivory Coast and are described in detail in the book, together with results obtained hitherto, mistakes made and schemes for the future. The author also considers the sun's energy as an auxiliary to thermal energy.

Experiments in the utilization of tidal energy go back to the first half of the eighteenth century, though its definite utilization is still a remote possibility. The most notable scheme has been worked out by the Société d'études pour l'utilisation des marées, and is to be tried out in the estuary of the Rance. The Passamaquoddy scheme (U.S.A.) and the Aber Wrac'h scheme (France) have been dropped.

Summing up, the author makes the point that all research into the utilization of the sea's energy may be traced to the fear that the main sources of energy now existing (coal, petrol) may fail. However, we may reasonably enquire whether the splitting of the atom and its use as a source of energy will not, once again, relegate research into the utilization of the sea's energy to the field of speculation and pure scientific curiosity.

405 WALLES, R. *Windmills in England.* London, Architectural Press, 1948.

An illustrated survey with technical details. Basing his conclusions on Dutch practice, the author believes that there is a future for these picturesque structures.

406 *Congrès du Vent*, Carcassonne, Bonnafous, 1946.

The collected papers submitted to the Windpower Congress held at Carcassonne on 23 and 24 September 1946. Most of the writers deal with the various problems connected with practical use of the winds for the production of power: description of several types of wind turbines, a study of the results secured, possibilities of development, technical and legal problems raised by the linking-up of many small wind generating stations with the general electric distribution network.

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